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RAYMOND C. MOORE
Editor

NOVEMBER—DECEMBER, 1922

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CONTENTS

Problems in Oil Geology and Their Advancement Through Co-operative Research 509
By DAVID WHITE

What the Oil Company Expects of the Geologist 516
By ROBERT S. ELLISON

Geological Work in the Carpathians 523
By WINTHROP P. HAYNES

Some Graphical Methods for Appraising Oil Wells 533
By PAUL RUEDEMANN

EDITORIAL

Studies in Petroleum Geology,
RAYMOND C. MOORE 545

RESEARCH PROBLEMS

Temperature of Fluids in Wells,
F. H. LAHEE 547

GEOLOGICAL NOTES

Geological Section in Western Kansas,
CHARLES T. LUPTON 549

Oil Possibilities of South Dakota,
W. T. THOM, Jr. 551

REVIEWS AND NEW PUBLICATIONS

ElDorado, Arkansas, Oil and Gas Field,
SIDNEY POWERS 554

ASSOCIATION ROUND TABLE

The Denver Meeting, C. E. DECKER 557

Membership Applications 559

OBITUARY

ROLLIN D. SALISBURY,
W. E. WRATHER 563
GUY HENRY COX,
V. H. MCNUTT 566

AT HOME AND ABROAD

Current News and Personal Items of the Profession 570

MEMBERSHIP LIST 572

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PROBLEMS IN OIL GEOLOGY AND THEIR ADVANCEMENT THROUGH CO-OPERATIVE RESEARCH*

DAVID WHITE

Oil geology at its present stage is but the beginning of a new branch of our science. It has no tradition such as has the study of the origin and mode of occurrence of metals. It has practically no history. Its real development, its possibilities, and its records of achievement are essentially matters of futurity. We who call ourselves oil geologists know that most of what we today call oil geology is little more than the application of the methods of stratigraphy, with specialization in structural study, to the discovery of oil pools. We have combined the technique, including mapping methods, developed in later years by the coal geologist, with the accumulated observations of the relations of oil pools to stratigraphy and structure in regions where oil has been discovered by the wildcatter or more recently by the geologist, who has applied the same methods of deduction and analogy. The discovery of the anticlinal theory was observational rather than deductive, and even at the present moment this so-called theory is perhaps more exactly a condition of observed relations than a real theory, architectured from component principles. In newer

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times we are studying also the relations of pools and structure to the occurrence of rocks accepted as mother substance of petroleum, to reservoir sands, and to waters and their movements. This is leading us to the more intimate study of the mother rocks themselves, of the sands, and of the history of deposition, deformation and erosion of the stratigraphic elements. Gradually we find our paths of inquiry leading into the composition of the sediments, the waters, the organic substances, and all the changes and mutual relations and reactions of the component parts of the geological and chemical ensembles, their original states, their histories, and their changes and products in response to chemical laws and dynamic forces and influences. Each step forward reveals new ramification, new factors and products, and new complexities as well as subsidiary branches to every problem. We shall find new compounds, new products, new relations, new reactions in multitudes, and—most probably—new elements and new principles.

In the practical world of oil field explorations oil geology is today scoring a great success, and our heads are in danger of being turned at the applause accorded by the industry and the public. But this success is only relative—merely the difference between a very little present knowledge and a former state of ignorance. We are steadily gaining in the ability to find new oil pools, but we have an amazing amount yet to learn. I conceive that in the estimation of the student of oil geology fifty years from now, the "ancients" in our science, will take rank little higher than "rock-hounds." If we are to live up to just expectations, we must make good. We must replace our present high sounding crudities and superficial smattering by a genuine understanding,—by the mastery of the principles of oil geology.

The necessities of civilization have driven the exploration for petroleum far beyond the present limits of research. There has not been time, there has not been the reflective leisure, the endowment, or even the favorable psychological atmosphere for those researches on which gradually to build up the geology of oil into a systematic science. The really great secrets of oil geology are yet to be revealed. Even the elementary or primary facts of the origin of petroleum, though prob-

ably divined in part already, remain to be unequivocally demonstrated.

Returning again to our oldest and most strongly established dogma, the anticlinal theory, witness that it is, in effect, still in the stage of debate as to its exact mode of application and operation. The geologist assumes, generally correctly to be sure, that if oil is present it will be found in anticline or dome or terrace, if one is present; and largely by analogies in the region or province, he may successfully predict the general area of the fold within which the oil is more likely to be found. But this oil is almost never distributed throughout the fold fully according to theory; too often it does not occur anywhere in that quadrant or section of the fold which, on present theory, would appear to most geologists as most favorable. Its pernicious vagary for occurring in flats or in synclines, or of absenting itself completely, is sometimes annoyingly in evidence and may not always be explained rightly on grounds of porosity. When we have made sufficient progress in understanding all the factors conditioning the origin and occurrence of oil we shall know not only why the oil so frequently is not present where it should be and why it does not symmetrically conform to present theory on many seemingly most excellent domes, but also why it is sometimes found under stratigraphic conditions now regarded as anomalous. At present we too frequently pass out guesses, instead of that certain knowledge that will make for greater economy and efficiency in oil field development.

Again we have learned that source rocks are important to look for in any new region; but we have not yet fully determined as to just what rocks are source rocks nor why, in so many cases, we have important pools in series that appear so nearly devoid of source rocks or that lie very far from deposits now recognized as the probable mother substances of the oil.

To illustrate the primitive state of our present knowledge I have used two most common problems of the practical field geologist. To illustrate briefly and in a fragmental way, a very small part of the work waiting to be done I will next outline some of the studies needed in a very restricted portion of the great field of oil geology, namely, oil shale. I leave to others

the more complete analysis of their problem, as well as the enumeration and classification of the studies required in other more important lines and fields.

The recent faiures and waste in the attempts to utilize oil shale for the production of artificial petroleum in the United States are due in part—in fact to an unknown extent—to our lack of knowledge of the origin, composition, relations, and possible distillation products of the highly varied chemical and mechanical organic constituents of the different oil shales and bituminous rocks. We should know the sources, present chemical composition and constituent compounds of the different kinds of fossil organic debris and the colloidal or solid products included in the ground-mass. Paleontological identifications of the fossil debris and the study of the results of geological changes must be followed or inseparably accompanied by microchemical tests and determinations of a most difficult sort. These are necessary to a knowledge of what the rock is made of. Next, we must ascertain the relations of the different kinds of component debris, residues, and other substances, many of which are optically distinguishable under the microscope, to the behavior of the rock under increasing temperature and under varying conditions of distillation. We must contrive a method of watching the microsections in a still so that by direct observation, if possible, we may learn the successive temperatures at which the different kinds of debris or products break down and what are the compositions and characteristic qualities of their products. By this combination of chemical and physical observations we will learn what the components produce, and which components contribute certain products under certain conditions. The settlement of these questions should enable us to determine by microscopical examination and chemical tests approximately what will be the character of the distillates to be gotten from a given shale, the type of retort to be used, and the conditions of temperature, pressure, etc., to be sought. Nearly every type of oil shale differs in its paleontology, its component debris and products, and by their present state. Had these researches, combining the paleontological, the dynamically geological, the chemical, and physical studies been

begun several years ago, the present situation as to our prospective oil shale industry would have been vastly better to say the least. Great losses would have been avoided. Losses to come may also be avoided. The physical tests should include, among other things, a series of shearing pressure tests, with records of temperatures induced, aimed at the solution of the genesis of natural oil from oil shale by geodynamic and geochemical processes. The question of natural cracking of the hydrocarbons in the strata under geologic processes also demands experimental research.

Before we can most effectively attack the host of unsettled problems bound up in the geology of petroleum, we should make a survey of the questions involved and requiring solution. The problems, so far as they can now be distinguished (new problems will later appear and apparent relations will change), should be defined, classified, and oriented according to their relations to one another and the main questions. This done, we should proceed to examine our work actually in progress, our interests and our capacities. These steps are necessary to plan any systematic attack. Structural, depositional, chemical, dynamic, and paleontological researches must be laid out in architectural plan and development. We then may cooperate in team work for the inauguration of researches bearing upon the different problems, in effect pooling then may co-operate in team work for the inauguration of research, we may be able to assist others in investigations beyond our own means or capacities.

I conceive it an important part of the work of this Association, an opportunity amounting to a duty in fact, for the members to systematically set up and catalog the problems now in view, putting our house in order, so to speak, for work and taking account of stock of the materials and oil geology equipment now in hand. If we clearly and logically envisage the problems and the pieces of work in sight to be done, we shall almost certainly bend our minds unitedly to the accomplishment of this work, and our efforts will be more constructive, as well as along lines most needed. The problems, which now obstruct the better understanding of oil geology will secure more widespread, more systematic and more effective attention. Re-

search students, candidates for advanced degrees in geology, paleontology, chemistry and physics, will be attracted and find subject-matter for these investigations to be carried out with the helpful interest of geologists and companies alike. Researches in certain field will, for their direct economic value, be conducted in company laboratories, or better, under the auspices of co-operating companies, to the benefit of the country as well as the industry.

Team work will increase as such studies progress in logical order and in the necessary fields, and the search for and the development of new oil deposits will gradually be transferred to a new and far more successful basis, founded on scientific research and the discovery thereby of principles, absolutely essential and possibly of great magnitude, not yet discovered. Not only may we all contribute to strengthen the work of others now under way, but it is more than probable that, as the great value of the researches is seen by the oil companies, funds for research laboratories and foundations will very wisely and profitably be established to further these investigations and so the real knowledge of oil, its sources and laws of occurrence.

Alexander Duessen and E. L. Estabrook expressed opinions to the effect that the U. S. Geological Survey could render greater assistance to the petroleum industry in carrying on stratigraphic studies than in structural mapping.

Colin C. Rae: The Midcontinent members should not conclude that the work of the United States Geological Survey has not been of considerable economic importance in the development of the Rock Mountain Oil Fields. We all realize that geological reports are revised in large companies as well as the Geological Survey, and that many details are only recognized after several wells have been drilled.

A little history of Rocky Mountain District Oil Fields might illustrate the value of the work of the Survey. In 1908, the first real large production in Wyoming was discovered in the Firt Wall Creek Sand of Benton, Cretaceous age in the Salt Creek Field. Consequently, oil prospecting was concentrated upon the location of favorable structures in the Cretaceous. Fortunately, the United States Geological Survey had mapped in detail many of the coal beds of the upper Cretaceous showing erosional and structural conditions. There is direct proof that several of the present producing fields were first located by the evidence shown in the Cretaceous coal reports. After the structures were located in the Cretaceous, the detailed work was not difficult.

Later, the sketch maps giving approximate contours of a great number of possible oil structures in Wyoming were valuable, since they were issued promptly, and gave sufficient information to enable a decision as to whether the expenditure of money in more detailed work was justified.

The Big Muddy Oil Field and the Baxter Basin Gas Field were probably due more to favorable government geological reports, than any other factor. Prospectors lacked the courage until a few months after a favorable U. S. G. S. report was issued. The Baxter Basin Field remained idle for several years after the drilling of several wells on a minor flexure of the structure, until the Survey issued a report giving evidence by contours, that the highest part of dome had not been tested. Recent tests have developed tremendous gas wells with some lower sands still untested. There are other fields which might be mentioned.

In conclusion, the history of oil development in the Rocky Mountain Region proves that the work of the United States Geological Survey has been of considerable economic value.

WHAT THE OIL COMPANY EXPECTS OF THE GEOLOGIST

ROBERT S. ELLISON[1]

Like any worth while subject, the one assigned to me affords opportunity for valuable discussion beyond the limits of this occasion. It is desirable, therefore, to confine my present consideration of the subject to a few points that appeal to me as involving the primary value of the petroleum geologist in the growth and maintenance of the petroleum industry.

In approaching the subject, I assume that the worth while producing and operating concerns in the business are exerting at all times their efforts and resources in the search for new commercial deposits of oil or gas, and at the same time are earnestly endeavoring to operate both economically and profitably the producing properties they hold and which legitimately must bear the burden of additional discovery and exploration work.

I realize that the usefulness and activities of the geologist depend in large degree upon the same factors as in other professional men. First in order, he should possess the homely but God-given quality of common or horse sense. Next, he should have all of the worth while technical training and study within his means. Finally, he should have as much practical work and experience as the limits of his years and opportunities can provide him. Then, in my judgment, and only then, is his opinion, either written or oral, deserving of the large amounts of money which are being expended more and more upon such opinions.

Those are broad, general rules and are marked by the usual exceptions, I am glad to be able to say, at least as to one or the other of the last two factors named. In any event, the geologist, or perhaps more fittingly phrased, the geological department, of any worth while oil company occupies today,

[1]Vice-President, Midwest Refining Company, Denver, Colo. This paper was read before the Denver meeting of the Association.

and in my opinion will continue so to occupy, an integral part of the organization and the heads of such department must be looked upon by the executives of any such company as right-hand men in the organization.

This does not mean even today that an oil producing concern cannot be built up and cannot successfully do business without an elaborate geologic force or without any geologists at all, for there are practical oil producers who can follow the lead of others, particularly in favored sections, and can succeed on a limited scale. For any extended operations either in point of time or over considerable areas, I would hesitate to undertake to pilot any concern, however, without loyal, competent, experienced geologists.

Having expressed my personal view, it is fitting that I define more definitely perhaps what to my mind is desired and sought by those responsible for the continued growth and expansion of a company, and for the proper expenditure of its funds in such connection. Certainly no wildcat drilling should be undertaken without the considered, written report of the responsible geologist. To my mind the ideal report of a geologist to the proper executive of his company must be something more than an opinion or a recommendation. It should be a carefully prepared, technical report, giving in sufficient detail the data upon which the geologist has based his judgment, so that the executive, or any other competent person, may independently review the facts or observations submitted and decide whether sound conclusions have been drawn from them. A trained geologist who has approached a problem with an open mind, made careful observations in the field, recorded them in such a manner that another geologist months or even years later may verify them on the ground, and presented them in a carefully written and logically reasoned report, has done a valuable piece of work for his employers, which is worthy of a permanent place in their records.

Failure to attain, or at least to approximate, such standards can only bring the geologist and his profession into deserved disrepute and contribute to needless waste and loss in operations. The oil industry has been, and perhaps always

will be, subjected to the more or less deserved criticism, in connection with wildcatting particularly, of being wasteful and extravagant. I do not consider it sufficient to meet this criticism by the sole reply that it is unavoidable and inherent in the business. I believe it can be and is being met by requiring more diligent, conscientious and intelligent work on the part of the geologists, and more careful and intelligent study of such work on the part of the executive. Certainly, this latter policy is already in many instances resulting in more acerage being declined than is accepted for drilling. Of course I am not now speaking of the stock promoter or of the fellow who preaches that an entire state like Wyoming, for instance, is underlain by vast oil pools merely waiting to be tested. I refer only to those companies striving ever to place their operations on a more efficient and businesslike basis, and which are not content to find after an expenditure of $75,000, or more, on a dry hole that the loss could have been avoided by more thorough, intelligent geologic work and careful consideration of same.

In this connection, the quality of keeping an open mind on the part of the geologist is too often ignored. Necessarily he must form conclusions and is expected to state them definitely in writing, as otherwise his responsibility would be slight, but the geologist who refuses to be convicted of error by the drill or by more accurate, careful work of other geologists, for example, is riding for a fall and frequently loss of position. It is only the man with an open mind who can truly profit by his mistakes, and as long as they do not exceed two out of five he is fairly assured of the confidence of his employer. We all make mistakes but the successful man neither magnifies nor minimizes them. He capitalizes them in his future work and turns into profit what would otherwise have been total loss.

I believe that the geologic examination of any area should in the first instance be undertaken usually at the direction of the head of the land department of the organization, or of such other proper executive as may be following that activity of the company. It is hardly desirable or fair to the geologist to be given simply a roving commission unless the general

purpose of the company or the particular circumstances at the time require that such be done in order to meet competition or for general reconnaissance work.

Very few geologists can hope to have sufficient opportunity to embody all of the different factors which must be available in making a worth while business of finding new structures or sands to prospect. There should be present in passing upon such matters the practical experience of the production head—the man who has actual charge of drilling and developing oil and gas, as well as the advice of those familiar with the transportation and marketing of such products when found. In addition to these, of course, there must be had the judgment of the executive or committee responsible for financing all important ventures of the company. The question of depth, of drilling costs, of actual operations, such as transportation, fuel, water and weather conditions, should all be considered and passed upon not by the geologist alone but by his associates in the other departments just mentioned. If this be true it necessarily means, to secure the best results, a close and friendly co-operation between the geologists and what are usually termed the producing and executive departments. No organization can be built or endure, in my judgment, without mutual confidence and respect among those charged with an important activity. This is true not only in the discovery and testing out of new structures where the geologist should check closely the drilling developments for confirmation of or variance in his original report, but should continue into the more settled and definite operations of a proven field.

With the successful completion of a commercial oil and gas well on a structure recommended by the geologist, it is important for him to assist in outlining a program providing for the least expenditure of time and money in definitely proving the productive area of the structure. The furnishing of information on subsurface geology, by careful correlation of well logs as drilling progresses in any field, is also of great importance to the Producing Department.

These things, to my mind, must mean a continued demand for qualified, worth while geologists. In fact, they call for

something more than a geologist. This has been true for some time and undoubtedly will lead more and more in the future to an even broader, more important advancement for those so adapted or fitted than if one's activity be limited solely to strictly geologic work. One splendid evolution from the geologic ranks is the petroleum production engineer or technologist, whose views and judgment are required and invaluable not alone in the first development of a prospctive oil field but even more and more so as the problems of securing oil in the face of increased difficulties becomes more and more pronounced. Another important asset of any geolgist of today is the ability not only to size up the geology of what may be an oil structure and be fairly familiar with the costs and problems of developing and operating same, but particularly in the case of new territory it is most valuable if the geologist is familiar with the proper procedure and means of securing leases or contracts upon fair and mutually satisfactory terms from the owners of the lands involved.

I appreciate that this is not at all vital or necessary in the discharge of a geologist's duty, or of particular value in case he is simply retained to pass upon structures or leases already held by his employer. Speaking frankly, however, it appeals to me that the ideal sought by most large companies with which I am familiar is embodied in the man who can be relied upon to protect and safeguard his company's interests not only in the actual finding, working out and passing judgment upon a prospective oil structure, but if occasion requires in the absence of more competent assistance, of securing leases subject to the executive approval and of passing upon, in a practical and understanding way, the actual operating and development problems involved. Such a man as this must invariably be a right-hand man in any worth while organization and his compensation is bound to correspond with such position.

This opens up a question of undoubted interest to all members of the geological profession and one which, in my mind, must be settled along certain fundamental lines. It is no doubt natural for a man hired for and charged with the responsibility of finding new oil deposits to feel that if he

can do this successfully for anyone else that he can do it as well for himself, or if he is of a cautious type he may naturally feel that he at least should have an interest, in the nature of a royalty, in any new structure located for his employer and at the same time receive his assured salary. I assume that this perhaps is a natural feeling and may be augmented by the private opinion, publicly expressed, of some of his friends. My opinion, however, is that the man who allows himself to feel that such should be the case cannot hope to develop along satisfactory lines with any worth while concern. He must work loyally and whole-heartedly for his employer the same as the man in the producing, the accounting, the legal, the sales, the manufacturing or any other department of the business. If he cannot do this happily and whole-heartedly, then he owes a duty to himself and his employer to sever their relations and go out and "get rich quick on his own hook." My judgment is that some men can do this. On the other hand, statistics will undoubtedly show such an enormous fatality among those who do endeavor to follow this course that we can reasonably expect to continue to have among our geologists the same type of trained, loyal, competent men as are found in the other departments of any successful company.

I believe that one of the greatest pleasures in any man's life is to be engaged in any work which he enjoys, which interests him and from which he receives adequate compensation for the needs of himself and his family, including those things which to an educated mind are as necessary as meat and drink. I think it is also true that the science or profession of geology calls for a type of men who take this interest and who receive their greatest pleasure in following the usual duties incident to the terms of their employment.

The degree of advancement or enlargement of scope beyond the geologist's ordinary duties, as well as the compensation paid for same, must depend more or less upon the same factors for growth or advancement as in any other line of work. If he possesses in sufficient degree the three principal factors first enumerated in my remarks and so desires, I would say unhesitatingly that he has ample opportunity for enlarging

his activities logically into the land or producing departments of his company, where with a more actual grasp and understanding of the problems of handling men on a larger scale, and the expenditure of large sums of money and the necessity of securing adequate returns therefor and thereon, he can easily head for the highest position within the gift of his company. This is a matter as in any other profession or business, depending upon the desire, the opportunities offered and the ability of the man himself. On the other hand, I can readily conceive of his remaining active in his chosen profession and attaining such reward and renown as must satisfy his every ambition, and after all, perhaps, no man can hope for greater success than that.

GEOLOGICAL WORK IN THE CARPATHIANS

WINTHROP P. HAYNES

INTRODUCTION

Several geological trips made in parts of the Carpathian Mountains in the company of Galician or Czech geologists during the spring and summer of 1922 have enabled the writer to become familiar with their publications, method of work, and some of their problems.

Inasmuch as the chief oil fields of Central Europe lie in this region some reference to recent literature may be of interest to American geologists, comparatively few of whom have had opportunity of working in the field with Central European geologists.

RESUME OF CARPATHIAN GEOLOGY

TOPOGRAPHY

The great chain of the Carpathians is generally regarded as commencing north of the Danube near Pressbourg (Bratislava) Czecho-Slovakia, and extending in a great arc eastward and southward to the Portes de Fer where the Danube cuts through the chain in western Roumania. This great arc is easily subdivided into three parts which differ in trend, vertical and horizontal extent, features of relief, stratigraphy and structure. (See map I).

1. *The Northern Carpathians* extend from Pressbourg to Dukla Pass and are a complex mass with a series of chains of alpine structure with a general E-W trend in the northern part, and ranges of metamorphic and igneous rocks farther south, which give rise to very diversified topography. The highest range is the Tatra Mountains, chiefly granitic, with a maximum altitude of 2663 meters (8633 feet).

2. *The Central Carpathians* extend from Dukla Pass to Buzeu Pass and are of more simple types consisting chiefly of a series of NW-SE chains formed of the Flysch formations. A doming in the central portion has brought the crystalline rocks to the surface. The mountains are much lower and less rugged in this zone.

3. *The Southern Carpathians* extend from Buzeu Pass to the Danube at Portes de Fer in a general E-W direction and differ widely from the others, owing to the predominance of crystalline rocks. Although the peaks are lower than in the

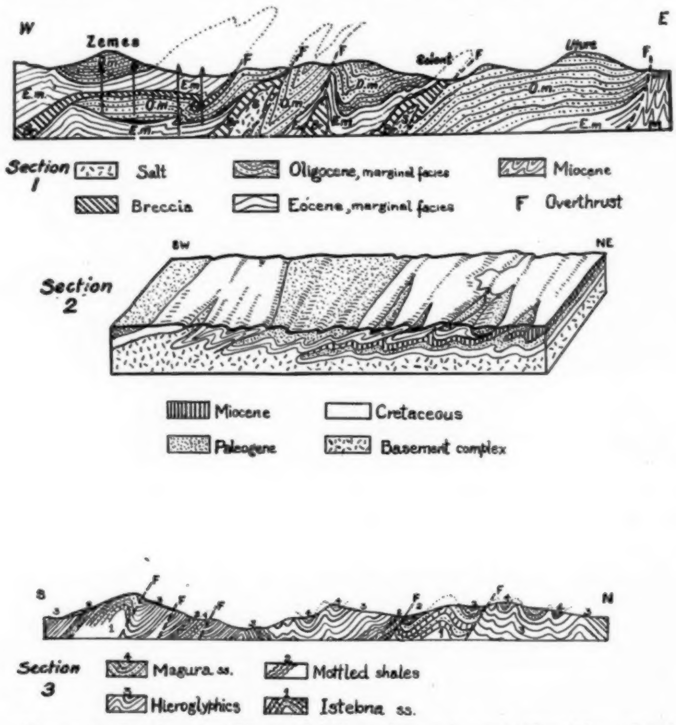

Figure 1, Section 1. West of Zilina, Moravia and Slovakia. Section 2. Southwest from Nadworna, Galicia and Carpathian Russia. Section 3. West of Bacan, Roumania.

Tatra those exceeding 2,000 m. (6500) feet are much more numerous than in any other part of the Carpathians. This portion was formerly called the Alps of Transylvania.

GEOLOGY

The Northern Carpathians are divisible into three geologic zones: (1) an outer zone composed of sandstone and shales

and marls of Cretaceous and Early Tertiary ages which forms the main mass of the Carpathians, (2) a middle zone consisting of a complex of formations, with a basement chiefly of metamorphic rocks overlain by Permian and early Mesozoic strata, and (3) an interior zone of Tertiary volcanic rocks[1].

The Central Carpathians are composed of zones 1 and 3, but near the central and southern end the crystalline complex of zone 2 reappears.

The Southern Carpathians are almost entirely composed of zone 2 with the Flysch of zone 1 along the eastern and southern part.

Stratigraphy

The following table (A) gives some of the major subdivisions of the Carpathian Flysch (Cretaceous and Tertiary) encountered in zone 1, and also in the sub-Carpathian border zone beyond the mountains.

It is impossible to make exact correlations at present or to give detailed stratigraphy here. This table merely represents a general approximation for the various portions of the Carpathians, compiled by the writer from the latest data available.

Structure

The three structure sections accompanying this report are selected to show the characteristics of the structure in the Flysch (zone 1) of the different parts of the Carpathians. (See Map I for location of sections).

Section 1 is based on work of the Czech geologist, Dr. Kettner and shows his interpretation of the structure in a part of the northern Carpathians in Moravia. Section 2 is a composite section after the Polish geologist Dr. Nowak, and shows the general structural features of the northern part of the central Carpathians in Galicia. Section 3 is after the Roumanian geologist, Dr. Voitesti, and shows his interpretation of the structure of the southern part of the central Carpathians in Roumania.

GEOLOGICAL WORK

Owing to the extremely variable topography of the Car-

[1]The High Tatra Mountains are an outlier chiefly of crystalline rocks of zone 2 in zone 1. (See Map I).

			West	East	Eastern Galicia	Roumania	
NEOGENE	Pliocene	Levantic	Gravels			Conglomerate, sandstones, marls	
		Dacic	not recognized			Conglomerate, sandstone, marls Fresh and brackish water; lignite	(oil horizon in Moreni and Baicoi fields)
		Pontic	Congeria beds			Sandstone and marls (Marine and brackish water)	(oil horizon in Bustenari and Campina)
		Maeotic	not recognized			Sandstone and clay marls (Fresh and marine)	
	Miocene	Sarmatien	sands, marls and clays	Cerithium beds	Cerithium beds	Clay marls, oolitic limestone, gypsum and salt Sandstone and marls, some gypsum	
		Tortonien	" " "	Salt formation	Salt formation		
			2nd Medit.			Sandy marls and sandstone, tuffs	
		Helvetien Burdigalien	sands, marls and clays	(Sub-Carpathian)	Red Clays	Conglomerate and sandstone	
				Great Unconformity			
PALEOGENE	Oligocene	Upper	Magura sandstone		Dobrotow beds Krosno beds Sloboda conglomerate (locally)	Menilite slates, bituminous shales "Meletta" beds. Kliwa sandstone (locally)	
		Lower	Hieroglyphic beds	Beloweza beds Menilite slates	Menilite slates Kliwa sandstone (locally) Menilite slates (chief oil horizon Boryslaw)	Conglomerate and Foraminiferal marls	
						Unconformity in East	
	Eocene		Mottled shales	Mottled shales (sandstone locally)	Hieroglyphic beds Pasieczna limestone (locally) Mottled shales Cieskowice sandstone (locally)	Hieroglyphic sandstone series (given local names) Sandy marls and limestone with "Nummulities," Lutetien age (Middle Eocene)	
			Unconformity				
	Cretaceous	Senonien	Istebna sandstone	(not recognized)	Jamna sandstone	Marly sandstone with Inoceramus. (Mingling of Northern and Alpine faunas) (Poorly represented)	
		Turonien Cenomanien	Inoceramus beds	Ropianka beds (Inoceramus)	Inoceramus beds	Conglomerate and sandstone Godula sandstone (mingling of northern and Alpine faunas)	

pathian region there is a great difference in accessibility and many parts have remained practically unstudied up to the present. The steeper mountain slopes are almost universally covered with a dense growth of evergreens and hard woods while the broader valleys and gentle foot-hill slopes are extensively cultivated. In consequence outcrops are frequently lacking over wide areas.

To add to the difficulty of geological mapping the formations are of the peculiar facies known as the Flysch, already briefly described. These littoral and shallow water sandstones and shales are extremely difficult to subdivide owing to great similarity in lithologic character and almost complete absence of index fossils or in fact any fossils of recognizable character in the northern facies. Still further difficulties are due to complex folding, including many overthrusts.

Early Work

The geological work previous to the present century is nearly all of a very general nature and the old Austro-Hungarian maps have very little value. General subdivisions such as the "Carpathian Sandstone" are used on these old maps and include sandstones of Cretaceous (Jamna sandstone) and Oligocene (Magura sandstone) ages.

It is obvious therefore that most of the older literature and maps must be discarded and only the work of the 20th century geologists considered.

Recent Work

Roumania. The most active men in the Carpathians of Roumania with whom the writer has come in contact are Drs. Louis Mrazec, director of the Geological Survey of Roumania, G. M. Murgoci and I. P. Voitesti. These men have all been making some very valuable contributions during the past ten years. Some of their most important publications are listed below. All of these geologists are anxious to exchange publications with Americans. The best general reference on the Geology of Roumania is the report by Dr. Voitesti "Apercu général sur la geologie de la Roumanie." August-September 1921. Boucharest. Ann. des Mines 4e Année No. 8-9. This contains an extensive bibliography on Roumanian Geology.

(A full translation in German with text figures has appeared in the Petroleum Zeitschrift Vol. XVIII, Nos. 14-20 May-July 1922.

In the same number of the Ann. des Mines is an interesting paper by Dr. Murgoci entitled "Nouvelles données relatives aux Gisements du Pétrole." Dr. Mrazec's numerous papers are all listed in the bibliography noted above.

Galicia. The Government Geological service dating from the close of the war had in its petroleum branch for a year or two a corps of very capable young men, chiefly trained in Switzerland, who were doing some excellent work in the Galician Carpathians and in the oil fields of the foothills region. Later, lack of funds caused them to cut down on their force and many of these men have now left to join the various oil companies.

At present the Director, Dr. Jan Nowak, Karkow, Wolská 14 Poland, a most capable geologist, has only a small force of two or three men remaining with him. He has a fund of information on the Geology of the Galician oil fields and the Carpathians. Some of the more important publications from the point of view of petroleum geology by him and his colleagues are listed below.

Nowak, Jan.:

"Le pétrole des Carpathes Polonaises sous le point de vue de la geologie regionale." Lemberg 1921. Roemer's Travaux Geographiques. Vol. VI.

"Uber die tektonischen Bedingungen des Erdölvorkommens in den polnischen Ostkarpathen." Petroleum Bd. XI. 1918.

"Les Unités tectoniques des Carpathes orientales Polonaises" 1914, Lemberg.

Tolwinski, Konstanty, Director of the State Petroleum Research Bureau at Boryslaw.

"Dislocations transversales et directions tectoniques des Carpathes Polonaises" 1921, Lemberg. Roemer's Travaux Geographiques, Vol. VI.

"Les gisements pétrolifères et les eaux souterraines en relation avec la geologie de Boryslaw" 1922, Krakow, Bull. No. 5, P. U. N. Stacja Geologiezna W. Boryslawiu.

Zuber, R. Prof. Univ. of Lemberg.

"Flisz i Nafta." 1918, Lemberg

These and numerous publications on various subjects by

other Polish geologists can easily be obtained by writing to these men and offering them American reports and books in exchange.

Czecho-Slovakia. Previous to the war most of the geological work in the northern and central Carpathians was done by Austrian and Hungarian geologists. V. Uhlig's "Bau und Bild der Karpathen" published in Vienna in 1903 and now unfortunately out of print is a well known general reference. Later reports by Uhlig and others have appeared in various Vienna publications and can generally be obtained through R. Lechner, bookseller of Vienna.

Since the war the Austrian and Hungarian governments have been cut off from the Carpathian region by the creation of Czecho-Slovakia and enlargement of Roumania and therefore very little has been published by any of their geologists on the subject.

Dr. W. Petraschek, of Leoben, Austria, published an interesting article in the Petroleum Zietschrift for August 1, 1922. Vol XVIII, No. 22., on "Neue Erfahrungen and Richtlinien zur Erdölgeologie in the Karpathen"; but he and the other Austrian and Hungarian geologists are now practically cut off from work in the Carpathians owing to the new political boundaries and unfavorable rates of exchange on Austrian and Hungarian money. In consequence a great field has been opened to the Czech geologists who previous to the war were almost entirely trained in economic and structural geology in Bohemia and also in paleontology and stratigraphy in the famous Barrande basin.

They are now expanding their work and becoming familiar with the Flysch formation of Moravia and making a few trips into Slovakia. Eastern Slovakia and Ruthenia or Carpathian Russia are very difficult to reach from Prague, the capital of Bohemia, and therefore up to the present no attempt has been made by the Czecho-Slovakian Geological Survey to do any field work in this region.

The Geological Survey, under the directorship of Dr. Cyril Purkyné, has recently published several reports dealing with the geology of the northern Carpathians.

Some of these recent reports by Dr. Radim Kettner, Professor at the Technical University at Prague, Karlovo Nám. 19., and his assistants are published in Vol. II Pt. 1. of the Survey Reports.

Geology of the Petroleum Deposits of Bohuslavice and Vlárou.

Etudes géologiques dans le Flyche Carpathique á la frontiére Moravo-Slovaque.

La géologie du gisement de naphta près de Turzovka en Slovaquie.

Many short articles of historical nature relating to oil in the northern Carpathians written by Prof. J. J. Jahn and Dr. E. Schnabel of Brünn have appeared in the Petroleum Zeitschrift during the past year in Vol. XVIII.

SUMMARY

Difficulties due to the presence of political boundaries have cut down the scope of work and tended to keep the geologists of each country isolated, thereby preventing their studying typical sections in neighboring counties. This has led to many disagreements in correlation which can probably be in great part settled by a little co-operative work.

A great step in this direction was made at the Geological Congress in Brussels in August 1922 when the delegates from all of the Carpathian countries conferred together and organized a Carpathian Sub-Section of the Geological Congress which is to meet once a year to discuss problems of Carpathian Geology and arrange for some excursions.

One of the first duties of this organization is for each delegation to take up with its government the question of granting some sort of special permits for visiting geologists of the other Carpathian countries.

A Committee was chosen composed of one representative from each of the countries as follows: Roumania - Murgoci, Serbia and Croatia (Yougo-Slavia) - Petkovic, Poland - Nowak, Czecho-Slovakia - Kettner.

METHODS OF FIELD WORK

The geologists of Galicia and Czecho-Slovakia working in the northern and central Carpathians have a very good set of base maps to work on, made by the old Austro-Hungarian

Government and reprinted and somewhat revised by the new governments. These maps are the regular hachure-contour topograhic maps in black at 1:75,000 and with enlarged quarters at 1:25,000, and the sheets at 1:200,000 with forest areas in green and hachures in brown and rivers in blue. For detailed mapping the maps at 1:25,000 are used exclusively and have proved very satisfactory.

In northern Carpathians most of the work has to be done on foot following the stream beds and dips and strikes are plotted on the map by means of the customary symbol. Colored pencils are used to indicate the formations and the map is colored in the field as the work progresses. Localities of interest are noted on the map with a letter and number and notes made and perhaps a section drawn in the notebook. Owing to the prevalent steep dips this method of mapping is satisfactory and results in a geological map whose accuracy depends largely upon the correctness of the indentification of the various formations.

Where outcrops are widely scattered and the formations are similar in lithologic character and lack fossils many different interpretations of the geology may be given by geologists working in an area and it requires co-operative work to establish the correct solution of the problem.

There is a tendency for the Galician geologists, trained in the Swiss school, to explain their geologic features by extensive, unusually flat-lying overthrusts, while the geologists of the Bohemian School employ commonly reverse faults of steep dips.

The writer has noticed there is a general tendency for the geologists who have worked in the Carpathians to question and frequently to discount the work of others. This is quite in contrast with their general courtesy shown to a visiting geologist. The writer has always been cordially greeted and given free access to maps and reports and personally conducted on field trips to interesting areas.

GEOLOGICAL PROBLEMS

Besides the general problem of mapping in detail the Flysch and solving its structural complexities there are two big

problems on which some of the geologists mentioned are working.

Salt Formation. Dr. Voitesti has been especially engaged with the problem of the origin of the salt beds and salt domes in Romania. This salt is found all along the Sub-Carpathian zone in greater or lesser amounts and so it also interests the Galician geologists.

The relation of the oil to the salt is also receiving considerable attention in Romania.

Salt Water Problems. Dr. Tolwinski has been collecting sub-surface data on the salt water invasion in the fields about Boryslaw through his research bureau, and has published some important papers on the subject.

Sept., 1922. *Prague, Czecho-Slovakia.*

SOME GRAPHICAL METHODS FOR APPRAISING OIL WELLS

By PAUL RUEDEMANN[1]

The problem confronting every engineer when planning the details of a large appraisal task is how can the efficiency be increased without hazarding the ultimate results. There are many steps in large valuations which can by proper organization and careful study be made the most simple instead of the most tedious part of the work. Perhaps no one part requires more time than the computations incident to the valuation of future recoverable production after all predictions and estimates have been made. There are many others that can be simplified but will not be dwelt upon in this article as the purpose is to discuss certain charts in connection with the part mentioned.

The necessary procedure in all appraisal work if done by the Annual Analytical Method is (1) to construct curves suitable for estimation of future reserves, (2) to ascertain probable future production of each well from the proper curve, (3) to predict future prices, (4) to predict future cost of operating (5) to chose a satisfactory discount rate and (6) to determine cost of development on locations not yet drilled. These are the primary requisites. There are, of course, numerout less important points to consider which are more or less dependent upon the purpose of the appraisal and the conditions under which made. For any well, having made all the necessary estimates the final step is to combine these and obtain the result, which is the present worth of the well.

The work mainly required in the calculation is first, to determine the future production of the well; next, to read the future price corresponding with each year's production; third, to multiply these together in order to obtain the gross yearly value; fourth, to list the cost of operating the well for each year shown; fifth, to subtract the cost of operating and se-

[1]Geologist and appraiser—Johnson, Huntley & Somers.

cure the net future revenue anticipated each year; sixth, to list the discount factor to be used for each year and by multiplication obtain the present value and lastly to total the yearly present value and get the total present value. For a well of ten-year life 71 operations are normally required to get the result.

By having the prices and cost of operating previously discounted, one step can be eliminated but that is all. It requires two persons, one tabulating and reading and the other multiplying to make any progress by a calculating machine. Considering the time for listing production, prices, costs and results in addition to the computations, at least twenty minutes are spent for a well of more then ten-year life. A thousand such wells would mean forty-two working days of eight hours each for two people. Thus it is evident that there is a possibility for shortening the labor.

With this in mind a group of graphical methods were developed which could be used as the conditions warranted. In many cases instead of forty-two days for two persons the work could be done in ten to twenty days by one person and frequently less.

Three types of charts are presented:

1. All valuations as of a fixed date.
2. Valuations of variable dates not sufficient in any group to justify use of method (1), and the chart one where all readings are directly plotted.
3. As in (2), but a part of the factors are computed and certain readings refer to dates and not amounts.

All charts are constructed using operating cost on a well-year basis. This is the most difficult but most accurate way.

TYPE I. ALL VALUATIONS AS OF A FIXED DATE

The simplest form of chart possible is one in which the total present value can be secured in one operation. This is possible only when a composite decline curve is being used for estimating future production and all the valuations to be made are as of a fixed date. March 1, 1913 is a common fixed date in making valuations for Federal Taxation purposes.

Assuming that a composite decline curve is used, it is evi-

dent that by separate valuation of each well much work is duplicated. As the amount of production is dependent upon

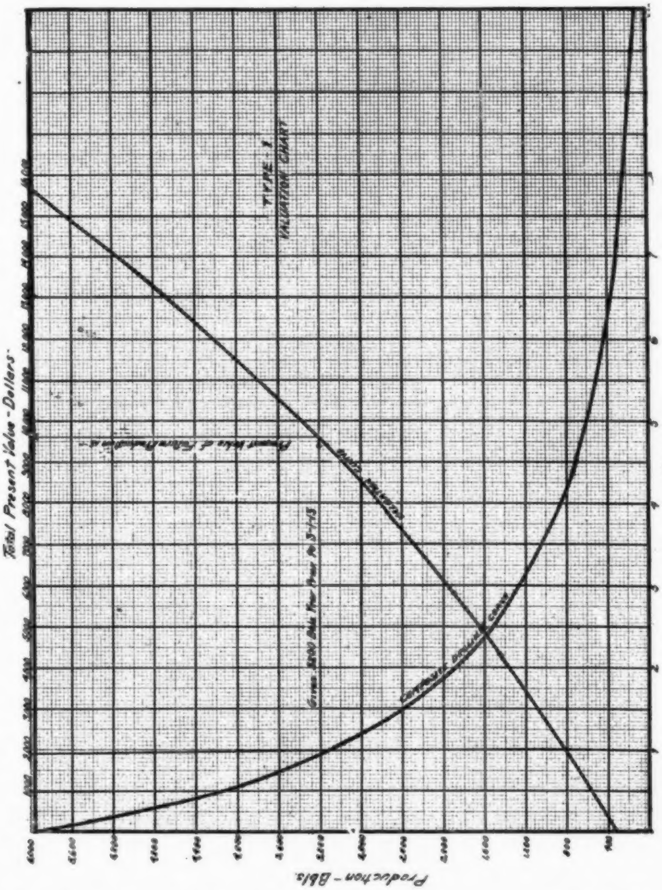

Plate I

the size of the well, wells of equal size will result in the same value.[2]

[2]Refinement of size-age is omitted in this discussion although the problem can be applied with the same practicablity where age of well is considered.

From any composite decline curve valuations of a series of wells should be made each year smaller by a year or more of production than the previous one. As a rule, about eight wells will suffice. The future production can be read in relation to the total for the year prior to date of valuation; the average per day on date or some other convenient amount. By plotting the size on the ordinate and the total present value on the abscissa, it will be found that the points arrange in a curve or straight line. Thus, by knowing the size of the well, its value can be found by reading from the graph.

The chart, Plate I, is an illustration of the fixed date valuation curve. For the purpose of this article the computations were made by slide rule and not with the usual required exactness. No price or cost changes have been postulated, although both should properly be considered. The computations for the curve are as follows:

Production Year Prior to date. Valuation. Bbls.	Total Net Present Value. Dollars
6,000	15,633.00
1,900	5,805.00
850	1,996.00
410	490.00

The time spent in constructing the curve is negligible if distributed over the valuations made from the curve. We may therefore compare the actual time consumed in obtaining valuation from a curve with the ordinary computation method. To determine total value, given the size of the well requires but one operation, using the curve; the normal number of operations which are required to determine the total value for a well of ten-year life is seventy-one.

Only one person is required to carry out the work by chart while two are necessary when multiplying by machine. Actual time is two persons twenty minutes each against one person two minutes. Where hundreds of wells are involved this saving means many days. Not only this, but the possibility of errors is almost eliminated. Mistakes in computations to obtain curve are revealed by irregularities in the arrangement of the points. On the other hand, by machine method a well

of ten-year life offers 71 chances for error, any one of which means much time lost in checking and retotalling.

The error in reading from the curve depends upon the scale. By charting on a large sheet, a valuation can be read with a maximum error of two percent plus or minus. This is more accurate than it is possible to estimate future production by decline curves.

As a simplification of graph 3 to be described later, a series of such curves could be constructed for as many years as the composite decline curve can be used. This would mean a series of computations similar to those described but each under different prices and operating costs.

TYPE II. VALUATIONS AS OF VARIABLE DATES. ALL READINGS DIRECT.

This is perhaps the slowest type of chart to use but one of the simplest to construct. The data are all plotted on logarithmic paper for convenience. On quadrille the lines would meet at zero which makes interpolation difficult. Of course logarithmic paper prevents expansion of scale and the inaccuracy increases with increase in size of well. Plate II illustrates a chart of this type which is not arranged with as much detail as is possible. By using various colors for units, fives, tens, and hundreds, the points can be more readily found.

There are three sets of lines (1) cost of operating per well year, (2) net value per bbl. and (3) discount factor. The lines for "cost of operating" are plotted first; on the left of the chart is the scale for production; and in the upper part the cost of operating per barrel. Two or three points can be determined easily for each line. For instance, a 1,000 barrels a year with a $500.00 operating cost is 50c a barrel, and 100 barrels a year with the same cost is $5.00 a barrel. By working in tens, hundreds and thousands, the points for each line are quickly found. The lines for "net value per barrel" are plotted next. The production scale already on the left is one guide and a net value scale, at the lower end, is the other. As in the case of cost of operating, all points are plotted as multiples of ten. For example, a net value of $2.00 a barrel for 1,000 barrels gives $2,000 and for 100 barrels gives $200. Having

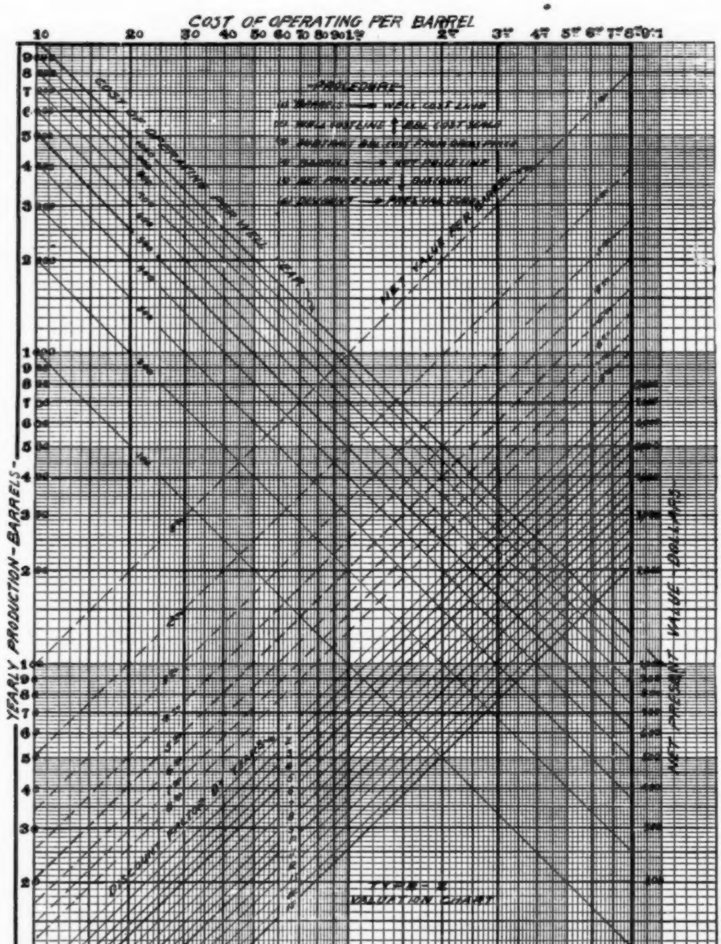
COST OF OPERATING PER BARREL
YEARLY PRODUCTION-BARRELS-
NET VALUE - DOLLARS-
NET PRESENT VALUE DOLLARS
NET VALUE PER BARREL
COST OF OPERATING PER WELL PER YEAR
VALUATION CHART

Plate II

the net value it is now only necessary to discount the amounts to find present value. The lower, already fixed scale, and the right hand scale are used, the right scale being the discounted net value. Again the 100, 1,000 and 10,000 lines aid in determining the location of the lines. $1,000.00 discounted one year at 10% is worth $953.46 and $10,000.00 is discounted to $9,534.60. Similarly the discount factor may be plotted for each other year. As many lines can be drawn as the years in the well of the longest life. Generally twenty are sufficient.

Since net value lines and discount lines are both plotted against the lower scale, in reading it is possible to progress from net value, to discount and to present value without any intermittent reading. Given, for example, the data shown in the following table: to find the net value.

Year	Future Producton	Future Price per bbl.	Operating cost per well year
1	2,000	2.20	400.00
2	1,000	2,30	500.00
3	500	2.40	600.00

Start on left scale at the 2000 bbls. production line, move horizontally to right to intersection with the $400.00 operating cost line, thence vertically upward and read cost per bbl., which is 20c. The future price the first year is $2.20 less cost of operating leaves $2.00 net profit. Again follow the 2,000 bbl. line to right to intersection with the $2.00 net price line, thence vertically down to intersection with 1st year discount line, thence horizontally to right and read the present value, which is $3,750.00. For the second year begin at the 1,000 bbl. point, read to $500 cost operating, thence to $1.80 net price line by interpolation, thence down to 2nd year discount, and thence to right and read present value, $1560.00. The last year the cost of operating is $1.20 a barrel and gross price $2.40 or a net of $1.20 and the present value $480.00. The total present value for the three years s $5,790. By computaton the value obtained by computation would have been $5,845.40, and there is thus an error of 0.9 percent.

Considering the saving in time such an error is warranted. But because of the necessity of referring to price and operating cost tables it is not as practicable as the method to be

described next. The advantage is that it may be applied with any set of production, cost or price figures.

For a well of ten years future life, 61 operations are required as compared with 71 by ordinary calculation. However, the operations by the chart are much quicker because no multiplications are required and instead of two persons with a calculating machine, one person with a chart can complete the work in less time than the two would.

TYPE III. VALUATIONS AS OF VARIABLE DATES. READINGS REFER TO DATE

Three separate diagrams are required to make a valuation, (1) Discounted Price and Production, (2) Operating Cost Check and (3) Total Present Value of Cost of Operating.

The first set of lines of diagram 1, Plate III, consists of curves of discounted future prices and lines of production. The prices are plotted first using a scale on the left for years and a lower scale of discounted price. For lack of room the amounts have been carried out for ten years only. However, the operating cost lines are for a longer period.

The predictions were made in a particular case where war inflation was a factor and consequently show a more rapid increase in the early life which gives the curves a peculiar turn at the lower end.

Having plotted the price curves, it is a simple matter to arrange a scale and the production lines. Using the lower scale of price, decide on the size of the yearly production of the largest well likely to occur in the field and then fix the maximum limit of the right scale of gross present value. This should be adopted in units easily divisible and convenient to read. Two or three points are sufficient to plot each line. The points are readily computed, for instance, 100 bbls. at $1.00 discounted price is $100.00 gross present value, 200 bbls. is 200 etc. Similarly 100 bbls. at $4.00 gives $400.00, the second point for the 100 bbl. line.

These two sets of lines are all that is necesary to find the gross discounted value of the well. Cost of operating is later deducted to obtain the net value.

As the end of the life of the well is reached the total income

TYPE 3 - VALUATION CHART

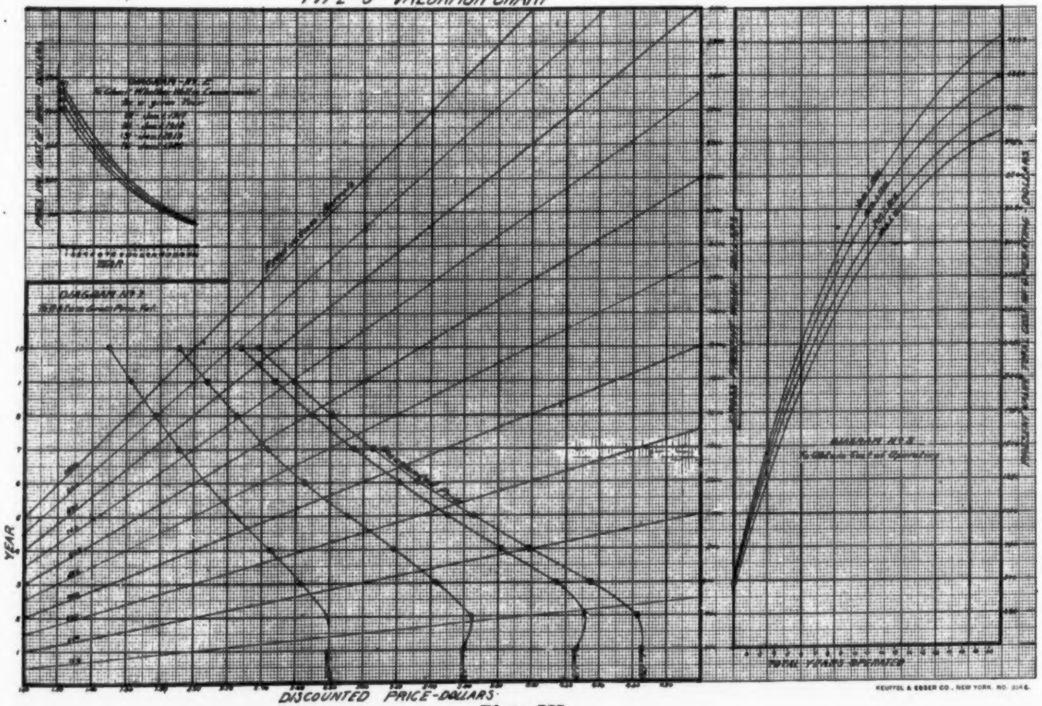

Plate III

may be less than the cost of operating. When this occurs the well has reached the end of its commercial life. Cost of operating is generally computed as an average of all wells. Few companies have the data by leases, and consequently, wells which are normally operated are eliminated due to the averaging. However, the larger wells in the group, by having less than their rightful cost, compensate for the loss and the final results balance.

Diagram 2 is the check of commercial productivity. Each curve represents the yearly future cost of operating as predicted for the date indicated. By discounting several of the costs at the rate being used in the appraisal, sufficient points are obtained to construct a curve. On the lower scale is years and at the left, discounted cost. For instance, the intersection of the vertical line for the tenth year with any curve is horizontally opposite the discounted cost for the tenth year, or rather the present value of the cost ten years hence.

Having determined the commercial life and the gross discounted value, the subtraction of total cost of operating, discounted, results in the valuation desired.

Diagram 3, consists of curves of total operating cost, for any number of years discounted at the rate being used. By multiplying a few of the future costs as predicted for any year by the cumulative discount factor the present value of the total future costs is obtained. The cumulative discount factor produces the same result as multiplying each year's cost by its respective factor and adding the results. This does not hold true for increasing or decreasing cost predictions. In such instances the larger method of separate multiplication must be used. On the lower scale is total number of years and at the right total present value. If the well has ten years commercial life the intersection of the ten year vertical line with the proper curve indicates horizontally to the right, the present value of the total amount to be deducted from gross value.

For the wells completed any date other than shown by the curves, a more accurate result can be secured by interpolation between lines. This is an advantage the graphical method has over the normal one in that a minimum of predictions is required.

Example: A well was completed in January 1918. From the production decline curve for the region the following annual production is estimated:—

1st year	1,000 bbls.
2nd year	600 bbls.
3rd year	600 bbls.
4th year	150 bbls.
5th year	50 bbls.

Solution: Starting in year 1, left scale of diagram 1, thence horizontally to right to price line for January 1, 1918 thence vertically upward to the 1,000 bbl. production line, and thence horizontally to right, read gross value for the first year production. For the second year begin at the two year point of the price curve and follow through as before except that the 600 bbl. production line is used. For the fifth year a present gross value of $150.00 is found. This is likely to be uncommercial and therefore a check is made. On diagram 2, starting at fifth year line, thence vertically upward to the Jan. 1, 1918 line and thence horizontally to left it is found that it costs just $290.00 to operate. Thus the fifth year is eliminated and a commercial life of four years used. Next refer to diagram 3. As there are four commercial years, begin at the four year point, move vertically upward to the January 1918 line and thence horizontally to right to the scale and read total present value of cost of operating. The final results are:—

Year	Future Production bbls.	Gross present value $
1	1,000	3,600
2	600	2,190
3	300	1,075
4	150	1,075
5	50	Not com
		7,675.00
	Less total cost operating	1,475.00
	Present value of well	$ 6,190.00

In this procedure it is to be noted that no reference was necessary to either future prices or costs. This saves much time as the only date of valuation and future productions are required and the valuation can be made with few operations. For a well of ten years future life there are only 13 operations as compared with 71 by the ordinary procedure. Moreover,

only one person is needed to use the chart while two are at a calculating machine in the longer method. It is safe to say that a saving of from 80 to 90 percent is made in time without impairing the final results. Checks have been made and the maximum error found to be three percent, plus or minus.

In the long run this slight error compensates. At any rate, future production cannot be estimated within three percent and there is thus an error at the outset greater than that introducd by graphical valuation.

Other methods have been developed wherein valuation can be obtained in one to five operations for any sized well and with any type of decline curve, future price curve or operating cost. The charts are in preparation and will be given at some future date.

EDITORIAL

STUDIES IN PETROLEUM GEOLOGY

This number of the Bulletin presents as the leading article a paper by Dr. David White on the subject of co-operation among petroleum geologists in attacking the many problems in petroleum geology which are as yet unsolved, or only partially solved. Examples of the types of research which should contribute largely to better understanding of facts and principles in petroleum geology are cited in Doctor White's discussion. All of the members of the American Association of Petroleum Geologists and scientists who are interested in the development of petroleum geology will, it is hoped, give careful attention to the suggestion that the largely latent capabilities of this great society of workers in a rather young but exceedingly important division of earth science—our Association—may yield definite and very valuable contributions to the advancement of the science by giving attention in as united a way as possible to problems which are presented. It has repeatedly appeared in the meetings of the Association, especially in the discussions following various papers, that information is very frequently available which is of great value, and the statement has been made that few specific questions or problems could be raised on which the members of the Association could not offer from their observations and varied studies some material which would constitute worth-while additions to our knowledge.

With some of the considerations in mind which are here presented by Dr. White, the division of the Bulletin columns entitled Geological Notes was some time ago introduced, in order that opportunity might be presented for recording observations shorter in length and perhaps less formal in nature than those embodied in the papers read before the Association and published in its Bulletin. Doubtless the short contributions which have thus appeared add to the value of the Bulletin to its readers, but it would appear that a vastly greater body of interesting and often very significant information is not prepared for presentation under this head, than might, if specific attention were drawn to a certain line of investigation, be forthcoming. Consequently the suggestion by the Editor that the Bulletin might serve to crystallize the various lines of inquiry in the field of petroleum geology projected by members of the Association, and to serve in a measure as a clearing place for information gathered, has been the basis for the incorporation of a new department or division of the Bulletin whose only function it will be to present subjects of investigation in petroleum geology and allied fields and to record data offered in carrying forward the studies outlined. A definite statement of problems and studies focuses attention upon them, and it is obvious that the membership of the American Association can make a contribution to the science which could not, perhaps, be made in any other way.

This Editorial, following the general thought of the discussion so well

presented by Doctor White, is written to call special attention to the proposal that the members of the American Association of Petroleum Geologists unite to state clearly problems toward which investigation by various workers may be directed, to carry on the study of these and to bring together data which otherwise might never be recorded or assembled. It is proposed to carry in successive issues of the Bulletin a concise statement of problems which are outlined for study, that readers may be reminded of subjects concerning which special help in gathering data is desired. Attention should be directed regularly to this division of the Bulletin and a cordially active participation by all of the workers in petroleum geology will assure the achievement of results.

RAYMOND C. MOORE.

RESEARCH PROBLEMS

TEMPERATURE OF FLUIDS IN WELLS

To the Editor:

For some time I have been collecting scattered data on the temperatures of oil and water coming from drilled wells. This I have been doing with the object of studying and correlating the facts and attempting to arrive at certain definite conclusions, subsequently to be published. I know that many other geologists are likewise gathering information along this line. It is very difficult for any one of us to reach any satisfactory results without assistance from the others. Therefore, in view of the opportunity offered by this new department of the Bulletin, I should like to make an appeal to those who are interested in this problem to send me such data as they feel able to give. I should like to serve as a clearing-house for facts bearing on this subject.

In order to systematize the collection and recording of facts, I suggest the following outline as a guide For the solution of the problems involved, as many as possible of these questions should be answered:

1. State geographic location of well.
2. On what type of structure is well located (dome, anticlinal nose, terrace, fault, fracture zone, etc.)?
3. How is well located on structure?
4. Was well flowing or on pump when temperature measurements were made?
5. What was production when temperature measurements were made?
6. Is well producing from one or several sands? If latter, was any temperature difference noted in fluid from the different sands?
7. What is lithologic character of producing sand (lime, sand, or shale; fine or course; etc.)?
8. To what geological formation do producing sands belong.
9. What is the character of the water or oil produced (chemical composition, gravity, etc.)?
10. Under what conditions of casing is fluid being produced. State size of casing or tubing.
11. Where was temperature measured, at mouth of well, at end of lead line (State distance from well), or inside well (State at what depth)?
12. Is any gas produced with fluid (oil or water)? If so, how much?
13. Have temperature measurements been made at different times in history of same well? If so, what changes have been noted in temperature production, and other conditions? What was amount of production of oil, gas and water each time such measurements were made?

14. State offset conditions and whether temperature changes have been noted bearing any relation of history of offset wells.

Any suggestions from readers of this Bulletin will be highly appreciated. In any published result, credit will be given for data used.

Information submitted by correspondence will be held as confidential, if so requested. I shall be glad to exchange such data as are not regarded as confidential.

F. H. LAHEE.

GEOLOGICAL NOTES

GEOLOGIC SECTION IN WESTERN KANSAS

CHARLES T. LUPTON

During the past summer (1922), the Mutual Oil Company drilled a well 3840 feet deep in the southwest corner of Gove County, Kansas, which is near the middle of the western half of the state. The location is in the southeast quarter of the southwest quarter of sec, 27, T. 15 S., R. 31 W.

Although no oil or gas was encountered in this well, the record of the formations passed through will be of immense value to those doing drilling in other parts of this region. As far as the writer is aware no well has penetrated the Pennsylvanian rocks nearer this locality than the Vesper well in Lincoln County, 132 miles east and 21 miles north. Hence the well in Gove County is in the midst of almost unknown territory, in so far as the detailed character of the formations is concerned.

Log of Well in SE¼ of SW¼ of sec. 27, T. 15S., R. 31 W., Gove County, Kansas

		Feet
1	Blue, gray and yellow limey shales	0— 410
2	Soft white chalky lime (Ft. Hays)	410— 480
3	Blue, dark and brown shale and slate	480— 695
4	Sandy shale (little fresh water)	695— 700
5	Blue, dark and brown shale and slate	700— 795
6	Limestone	795— 800
7	Black shale	800— 850
8	Broken limestone	850— 915
9	Sandstone (water rose 400 feet)	915— 930
10	Broken lime and shale	930— 942
11	Sandstone, dry	942— 968
12	Shale	968—1000
13	Blue shale	1000—1012
14	Gray lime and white slate	1012—1032
15	Sand	1032—1045
16	Gray lime and white slate interbedded	1045—1083
17	Blue slate and shale	1083—1110
18	Sandstone	1110—1140
19	Blue and brown shale and slate	1140—1385
20	Sand (some water)	1385—1400
21	Lime and shale	1400—1454
22	Sand upper part interbedded with shale	1454—1510
23	Brown shale	1510—1540
24	Sand red	1540—1575
25	Shale	1575—1592
26	Sand	1592—1598
27	Red clay and shale	1598—1798

28	Sand (hole full of salt water)	1798—1808
29	Red rock	1808—1825
30	Red sand	1825—1978
31	Red slate	1978—2030
32	Sand	2030—2058
33	Red rock	2058—2180
34	Gravel	2180—2185
35	Red rock	2185—2210
36	Limestone	2210—2250
37	Red sand	2250—2290
38	Red rock	2290—2325
39	White gumbo	2325—2327
40	Red rock	2327—2410
41	Limey sand	2410—2430
42	Blue slate	2430—2435
43	Red rock	2435—2460
44	Limestone	2460—2465
45	Red rock	2465—2490
46	Lime shells and red rock	2490—2530
47	Red slate	2530—2540
48	Limestone	2540—2550
49	Red slate	2550—2560
50	Limestone	2560—2570
51	Blue slate	2570—2581
52	Limestone	2581—2585
53	Red rock	2585—2618
54	Limestone	2618—2658
55	Red shale	2658—2680
56	Red sandstone, shale and clay	2680—3095
57	Black slate	3095—3150
58	Black sandy shale (salt water in lower part)	3150—3230
59	Limestone interbedded with shale	3230—3310
60	Limestone	3310—3350
61	Blue light and brown shale	3350—3485
62	Sandstone hard at top (salt water)	3485—3535
63	Dark shale	3535—3540
64	Sandy shale and hard shells	3540—3640
65	Limestone sandy at base (hot salt water	3640—3752
66	Sand and limestone	3752—3780
67	Limestone	3780—3840
	Total depth	3840

The surface rocks in the locality where the well was drilled belong to the Niobrara shale or chalk. The first 480 feet of the hole (Nos. 1-2), were in the Niobrara. The upper part of this formation consists of blue, gray and yellow chalky shales, whereas the lower 70 feet is a white soft limy chalk known as the Fort Hays limestone.

Underlying the Niobrara chalk, (Nos. 3-8), from 480 feet to 915 feet, is the Benton shale. It consists mainly of blue, dark and brown shale and slate with some limestone interbedded with shale in the lower part. The 5-foot bed of limestone from 795-800 feet may be the equivalent of the Greenhorn member of the Benton.

The Dakota series, (Nos. 9-18,) was encountered from 915 feet to 1140 feet. As shown in the log, it contains four sandstones ranging in thickness from 13 to 30 feet.

Beneath the Dakota is the Commanchean, (Nos. 19-23,) extending from 1140 feet to 1540 feet. The upper 245 feet consists of blue and brown shale and slate and is the Kiowa shale, whereas the lower part, 155 feet thick, consists of sandstone and shale and is the Cheyenne sandstone. The lower part contains two sands, one 15 feet thick and the other 56 feet thick.

From 1540 feet to 3095 feet, (Nos. 24-56,) the rocks are mainly red in color and are classified as Permian, although some Triassic may be present in the upper part. The total thickness of this red series is 1555 feet.

Beneath the Dakota is the Comanchean, (Nos. 19-23,) extending from which was encountered in this well at 3095 feet and 755 feet of this series was drilled through to the bottom of the hole. The character of the formations changed abruptly in passing from the Permian into the Pennsylvanian, as the lower part of the Permian consists of red rock and the the upper part of the Pennsylvanian of black shale and slate. One prominent sand 50 feet thick occurs in the Pennsylvanian 390 to 440 feet below the top or from 3485-3535 in the log. Another bed of sandstone somewhat limy was encountered about 655 feet below the top of the Pennsylvanian, or from 3752 to 3780. It contained hot salt water. From the base of this sand to the bottom of the hole the rock is limestone.

The above interpretation is based entirely on lithology.

K. C. HEALD: In support of Mr. Lupton's statement that the well in Gove County drilled through Pennsylvanian rocks, are findings by P. V. Roundy, of the U. S. Geological Survey. A well in T. 24 S., R. 23 W., Ford County, Kansas, southeast of the Gove County well, yielded cuttings from a depth of 3640-3650 feet containing *Bairdia* n. sp., *Hallina* n. sp., *Amphissites centronatus* var., and*Amphissites* n. sp., cuttings from a depth of 3650-3655 feet contained *Fusulinella* ? sp., *Bairdia* n. sp., *Hallina* sp., and *Amphissites* sp. Mr. Roundy classifies this fauna as "lower Pennsylvanian, but not necessarily basal Pennsylvanian."

OIL POSSIBILITIES OF SOUTH DAKOTA*

With the extension of the search for oil into heretofore unprospected territory some attention has recently been given to the oil and gas possibilities of South Dakota and articles covering the possible resources of

*Published by permission of the Director, U. S. Geological Survey.

the State have been published recently by Roy A. Wilson[1] and A. B. Rowley[2]. Both of these articles fail to emphasize a factor which seems to the writer to merit the most careful consideration in forming an opinion as to the possible presence and location of commercial oil or gas pools within the State, namely, the probable existence of an elevated backbone of pre-Cambrian rocks connecting the Sioux quartzite area of eastern South Dakota with the Black Hills. In the eastern part of the State the Sioux quartzite (or granite) is directly overlain by the Dakota sandstone. This area of direct contact apparently tapers westward to a point located in the neighborhood of Pierre, beyond which point an increasing column of Palezoic and earlier Mesozoic rocks intervene between the pre-Cambrian and Dakota as the Black Hills are approached. North and south of this backbone of pre-Cambrian rocks it seems reasonable to assume that the pre-Dakota sedimentary column is thicker than above the ridge, and that local unconformities and deformations may be present along the flanks of the ridge. Records of deep wells in critical areas should be examined in the light of this general hypothesis to determine the presence of such an arch in the crystalline rocks, and the areal extent and altitude of such Paleozoic and early Mesozoic formations as may be present.

In another important particular, to some extent related to that just discussed, the reports published by Wilson and Rowley are probably in need of modification. Both reports are accompanied by structure contour maps drawn on the Dakota sandstone, which show the lowest point of the major north-south syncline as lying near Lemmon, South Dakota.

The original data on which the region south and southwest of Lemmon was contoured is to be found on pages 37 and 18, respectively, of the U. S. Geological Survey Bulletins 627 and 691-A. The original contouring of the areas was drawn on the top of the lower member of the Lance formation, and was converted to contouring on the Dakota sandstone by assuming a constant stratigraphic interval between the two horizons of 3,700 feet.

As a matter of fact this interval probably ranges from about 4,300 feet at the northwest corner of the State to 2,800 feet more or less at the mouth of Cheyenne River. This convergence probably does not take place uniformly, and adequate data is lacking to indicate just what the actual variation in thickness of the Upper Cretaceous sediments is. It is, however, believed that the synclinal axis of the Dakota surface will be found to lie a considerable distance west of the Lemmon when drilling has yielded further evidence.

Structural domes along the axis of the supposed arch in the basement rocks are believed to afford the best localities for wildcat tests, as such

[1]Wilson, Roy A., The possibilities of oil in South Dakota: S. Dak. Geol. and Nat. History Survey Bull. No. 10, 1922.

[2]Rowley, A. B., South Dakota may be center of wildcat work: The Oil Weekly, vol. 26, No. 11, pp. 10-11, 1922.

features may afford traps for oil or gas carried along by artesian flow from the west, and they may also be reflections of more pronounced structural features in the pre-Dakota rocks, some of which may be petroliferous in South Dakota.

W. T. Thom Jr.

REVIEWS AND NEW PUBLICATIONS

***El Dorado, Arkansas, Oil and Gas Field.* Bureau of Mines, Manufactures and Agriculture, Little Rock, Arkansas**

This Bulletin of 90 pages was published by the State of Arkansas during the latter part of June, 1922, and can be secured free. It consists of a paper by H. W. Bell and J. B. Kerr of the United States Bureau of Mines, 68 pages in length, describing drilling and production methods, followed by a reprint of two press notices of the United States Geologial Survey by K. C. Heald, et al., and a brief statement of recent developments, 3 pages in length. This is the second publication of the State of Arkansas dealing with petroleum, the first being a report on the mineral resources of the state. Aside from the very unsatisfactory and gaudy cover the Bulletins are very commendable. A map of the field on a scale of 2 inches to the mile and ten other plates are enclosed in a pocket at the rear of the publication.

The contribution by the Bureau of Mines gives a brief history of development followed by a very interesting account of drilling and production methods where special devices had to be brought into use to separate oil from water. For many months a number of wells flowed a thousand barrels or more a day of water and oil, under great pressure, and separation was made possible by the use of chokes and flow lines with bleeders for salt water, the pressure being held back by a reducer at the end of the flow line. In addition, there are methods of dehydration in common use.

Keen competition to make the first geological map of the El Dorado field between the United States Bureau of Mines and the United States Geological Survey resulted in a map by the former Bureau (Fig. 1), published August 18, 1921, by the Conservation Department of the State of Arkansas, at El Dorado, showing a long anticline extendng from west of north to east of south, with separate highs in secton 36, T. 17 S., R. 16 W. and sections 6 and 18, T. 18 S., R. 15 W. Not to be outdone, the United States Geological Survey issued a press Bulletin, on May 15th, 1922, mapping the geology of the producing area, but not connecting it with the adjacent wildcat wells and made the surprising announcement that the field is not on an anticline. Instead, they show six subsurface faults trending in a northeast-southwest direction and one in an almost east-west direction (See this Bull., vol. 6, p. 362). Following these absolutely divergent subsurface structure contour maps by two official Bureaus, the publication here reviewed unfortunately omitted the geological map of the Bureau of Mines in favor of the Geological Survey.

The general consensus of opinion is that the structure is an anticline with the highest point near the southwest corner of section 31, T. 17 S., R. 15 W., and W½ of section 6, T. 18 S., R. 15 W., extending southward

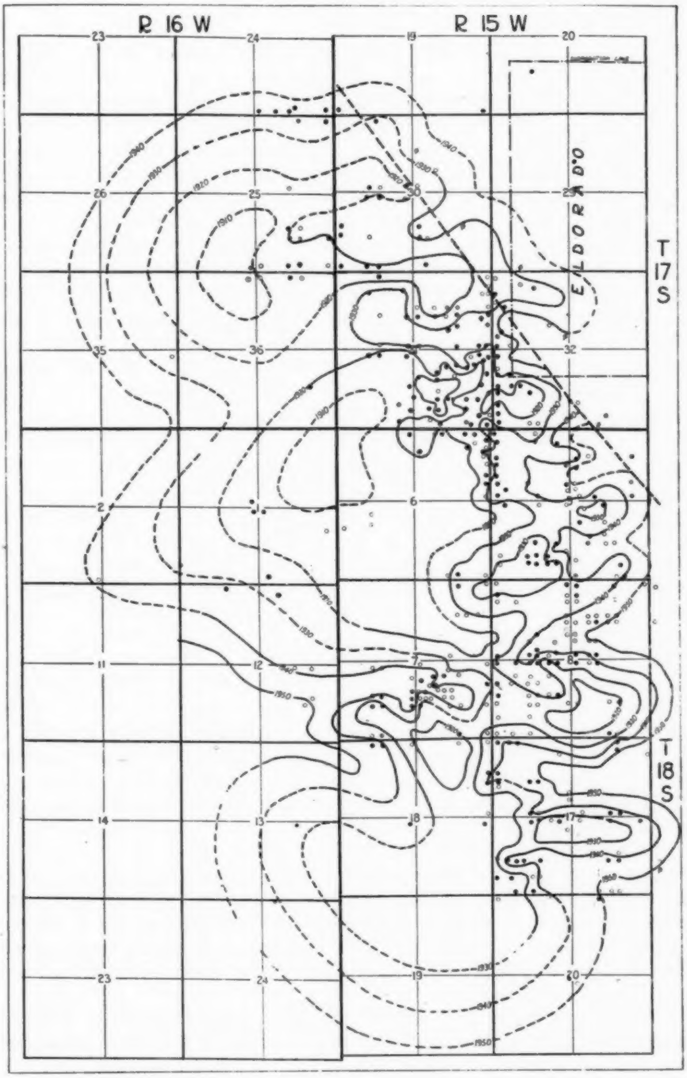

Fig. 1. Subsurface structure contour map of the El Dorado field by the U. S. Bureau of Mines.

through the producing area to section 9, T. 19 S., R. 15 W. The oil has clearly accumulated on the east side and in part along the axis of the anticline, especially south of the highest point in section 31. Gas is confined to the highest part of the structure in section 6, T. 18 S., R. 15 W., and section 1, T. 18 S., R. 16 W. As shown in the Bureau of Mines' map there are sharp folds or flexures in the producing sand. These dips have been interpreted by the Geological Survey as faults.

Owing to the abrupt, thinning and thickening of sands in this field, to the inability of most rotary drillers to tell when they are on top of the sand, and to the use of new and old steel lines which give very different measurements at a depth of 2,000 feet, it is not safe to attribute the irregularity to faulting. Moreover, surface faults and a few pronounced subsurface faults are becoming well known in Louisiana and Arkansas such as the subsurface faults through the Homer field and between Bull Bayou and De Soto fields. Besides the surface fault in section 32, T. 17 S., R. 15 W., there is another on the east line of section 1, T. 18 S., R. 15 W., striking northwest-southeast. Other pronounced faults are known in the vicinity of Stephens, Arkansas, near the Hunter well. A number of deep tests have recently been drilled in and near ElDorado field and these have found hot salt water in what is probably the Marlbrook marl at about 2,550 feet. The Frasier well in section 1, T. 18 S., R. 16 W., had an initial estimated volume of forty million gas in this sand at 2,528 feet. Another sand carrying salt water was found by the Humble Oil and Refining Company in SW¼ SW¼ of section 31, T. 17 S., R. 15 W., at 2,650 feet and the same sand was found by Constantin in the SE¼ of secton 6, T. 18 S., R. 15 W. The Constantin well reports sand and sandy shale from 2,660 feet to the bottom of the hole at 3,257 feet wth two streaks of red gumbo between 3,050 and 3,100 feet. The Cooper-Henderson deep test in section 19, T. 17 S., R. 15 W., reported lime below 3,055 feet, which was believed to be Lower Cretaceous. This well was carefully drilled and cored and the log is more reliable than the log of the Constantin well and the sand in the latter well may really be lime.

The first deep producing well near El Dorado was the El Dorado Nat. Gas Co. well, or No. 1, SE cor. NW¼ sec. 1, T. 18 S., R. 16 W., completed about September 1, 1922, in a sand at 2,948-2,952 feet. According to the Geological Survey this is the Blossom sand which is the producing horizon at Stephens, Arkansas, and Haynesville, Louisiana, and which has shown oil in the Humble Oil & Refining Co. well in sec. 6, T. 18 S., R. 13 W., at 2,975 feet.

The Smackover field, 12 miles north of El Dorado, and the East El Dorado field 4 miles east of El Dorado, produce from the Nacatoch sand at a depth of 2,000 feet in the former and 2,150 feet in the latter.

SIDNEY POWERS.

Tulsa, Okla.

THE ASSOCIATION ROUND TABLE

DENVER MEETING OF THE AMERICAN ASSOCIATION OF PETROLEUM GEOLOGISTS

The first regional meeting of the American Association of Petroleum Geologists was held in Denver, Colorado October 26, 27 and 28, 1922. The meeting was a marked success from the standpoint of number and character of papers presented, in vital interest which was sustained throughout all of the sessions for three days, and in point of attendance which was large. Sixty-three papers of high scientific value were scheduled on the program and most of them were presented and discussed in the meeting. Intense interest was manifested and sustained through all the sessions. Toward the close, the discussion had to be limited, but even then there was not sufficient time for the presentation of all the papers. The attendance exceeded the expectations of those most interested. Among those present the largest numbers came from Colorado, Wyoming and Montana, but a number came from California, Nevada, Arizona, New Mexico, Washington, D. C., Boston, Mass., New York City, Philadelphia, West Virginia, Chicago, Missouri, Texas, Nebraska, Kansas, Oklahoma, and Tampico, Mexico.

President W. E. Wrather shared the responsibility of presiding with Max W. Ball, the vice-president, C. E. Decker, the secretary and Mrs. Ada E. Mastbrook had charge of registration and Dr. R. C. Moore, the editor took charge of manuscripts and records of the discussions.

At the first meeting Thursday morning greetings were extended by Hon. James T. Duce, Oil and Gas Inspector of Colorado, and by Mr. C. A. Fisher in behalf of the Rocky Mountain Association of Petroleum Geologists. To these greetings response was made by President W. E. Wrather.

While most of the papers dealth with the oil geology of the Rocky Mountain region, a number treated of the geology of California, Texas, Oklahoma, Kansas, Alberta, Canada and Roumania. One correction should be made in the program to the effect that paper Number 58 on Permo-Pennsylvanian Glaciation in the Wichita Mountains should be credited to Dr. S. Weidman.

Two highly respected members of the association died since the last meeting, Rollin D. Salisbury of the University of Chicago and G. H. Cox of the Josey Oil Company, formerly head of the Department of Geology at the Rolla School of Mines. The obituaries for these men were read by the secretary at the beginning of the Thursday afternoon session. The one for Professor Salisbury, our first honorary member, was written by President W. E. Wrather, and the one for Dr. Cox by V. H. McNutt.

Entertainment was provided for all visiting members of the convention Friday afternoon when the citizens of Denver furnished automobiles for a mountain trip of about sixty miles out southwest of Denver, first to the site of a well being drilled with a core drill, thence up through

the canyons and along the mountain sides to the top of Look Out Mountain, and back through the Mining School town of Golden.

Social features included a dinner Thursday evening for the members of Sigma Gamma Epsilon, the Geological, Mining and Metallurgical fraternity, arranged by Lambda Chapter of the Colorado School of Mines, at the Shirley-Savoy hotel.

The climax of the social features was reached at the association dinner Friday evening in the Magnolia Room of the Albany Hotel, at which about one hundred and thirty were present. The program was one of great originalty. Max W. Ball served admirably as toastmaster and the toasts included "Stories of My Friend the Plainsman" by C. H. Wegemann; "How Old Was Nebuchadnezzar" and " How Old is Petroleum" by Rimrock Jones of Poison Spider, "The Interests of the Association" by W. E. Wrather; "The Making of a Pebble Pup" by E. F. Schramm; and "The Law Hound" and the "Rock Hound" by Wilfrid O'Leary. A number of original songs written for the occasion were interspersed with the toasts.

At the close of the meeting a group of the men started Saturday evening on a trip to the Salt Creek Field near Casper, Wyoming, but a terrible blizzard caught them on the way out from Casper, causing them to return to that city without reaching the field.

The executive committee of the association had several important sessions, and among other items of business decided, in response to an urgent invitation from Shreveport, Louisiana, to hold the next annual meeting of the association in that city March 22, 23 and 24, 1923.

The great success of the Denver meeting should be attributed first to the indefatigable and persistent efforts of Max W. Ball, to the able assistance of Charles M. Rath and Mrs. Ada Mastbrook, and to the fine co-operation of all the Rocky Mountain geologists, oil companies, and other organizations, and to the citizens of Denver in general.

CHARLES E. DECKER, Secretary.

REPORT OF THE RESOLUTIONS COMMITTEE

We, the members of the American Association of Petroleum Geologists, are deeply grateful to the people of Colorado and of Denver, for the welcome and the courteous hospitality extended to this Association on the occasion of this its semi-annual meeting. The Association is particularly indebted to the Denver Tourist Bureau for its active assistance in preparation for the meeting, the Albany Hotel for auditorium accomodations, and the individual citizens, whose generosity in furnishing transportation made possible the mountain trip.

The co-operation of the oil companies of the Rocky Mountain region is cordially appreciated for their financial contribution to expenses of the meeting, for their provision for the attendance of members of their geologic staffs, and for conveniences placed at our disposal.

The sincere thanks of the Association are expressed to the Rocky Mountain Association of Petroleum Geologists and their friends through-

out the Rocky Mountain region, whose whole-hearted contribution of time and effort have been so largely responsible for the success of this meeting.

Finally we extend our thanks to Max W. Ball, Charles M. Rath and Mrs. Ada M. Mastbrook for their ingenuity, industry and patience in the arrangements for and conduct of this meeting.

Respectfully submitted,
W. E. PRATT
K. C. HEALD
R. S. MCFARLAND
Resolutions Committee.

NOTICE TO MEMBERS

The vote on changes in the constitution submitted to the members of the association will be closed February 1, 1923. In case any members have votes which they still desire to turn in, they should be mailed as promptly as possible to the secretary, C. E. Decker, Norman, Oklahoma.

MEMBERSHIP APPLICATIONS APPROVED FOR PUBLICATION

The executive committee has approved for publication the names of the following applicants for membership in the Association. This publication does not constitute an election, but places the names before the membership at large. In case any member has information bearing on the qualifications of these applicants, please send it promptly to Charles E. Decker, Norman, Oklahoma.

(Names of sponsors are placed beneath the name of each applicant.)

FOR FULL MEMBERSHIP:

Tom J. Cullen, Casper, Wyoming.
Leon J. Pepperberg
R. E. Collom
T. E. Swigart

Charles J. Hares, Denver, Colorado.
Wallace E. Pratt
C. A. Fisher
Max W. Ball

J. Volney Lewis, New Brunswick, N. J.
Paul Weaver
D. R. Semmes
E. DeGolyer

Pierce Larkin, Tulsa, Oklahoma.
L. B. Snider
Sidney Powers
Charles T. Kirk.

James M. Douglas, Denver, Colorado.
Dean E. Winchester
Max W. Ball
Thomas T. Harrison

Roscoe E. Shutt, Mexico, D. F.
B. L. Laird
O. A. Cavins
R. C. Stoner

Barnabas Bryan, New York City.
Carl B. Anderson
Sidney Powers
A. F. Truex

Walter Krampert, Cheyenne, Wyoming.
Max W. Ball
Colin C. Rae
Harold T. Morley

Edward D. Lynton, Abilene, Texas.
Stephen H. Gester
Wm. S. W. Kew
E. M. Butterworth

Hugh A. Stewart, Denver, Colorado.
E. G. Sinclair
H. T. Morley
L. V. Fees

Nicholas L. Taliaferro, Berkeley, Calif.
G. C. Gester
S. H. Gester
Hugh B. Webster

John B. Whisenant, Duncan, Oklahoma.
Leon J. Pepperberg
W. E. Wrather
C. E. Decker

Robert V. Anderson, Menlo Park, California.
Max W. Ball
Dean E. Winchester
Charles T. Lupton

Karl H. Schilling, Bartlesville, Oklahoma.
Chas. C. Hoffman
Archie R. Kautz
T. K. Harnsberger

Henry V. Howe, Baton Rouge, Louisiana.
Ben K. Stroud
J. P. D. Hull
Clyde M. Bennett

Francis E. Vaughan, San Francisco, California.
F. B. Plummer
John R. Suman
W. F. Bowman

Joseph Jensen, Los Angeles, California.
Wayne Loel
Wm. S. W. Kew
Irving V. Augur

J. Claude Jones, Reno, Nevada.
Walter Stalder
C. Max Bauer
J. Elmer Thomas

Paul B. Whitney, Denver, Colorado.
Dean E. Winchester
Max W. Ball
Charles T. Lupton

Howard Clark, Utica, Ohio.
Frank Carney
George C. Matson
A. L. Beekly

Wilson B. Emery, Casper, Wyoming.
Clarence B. Osborne
Max W. Ball
T. T. Harrison

John B. Case, Los Angeles, California.
Wm. W. S. Kew
Irving V. Augur
R. E. Collom

FOR ASSOCIATE MEMBERSHIP:

Paul A. Schlosser, Laramie, Wyoming.
S. H. Knight
Eliot Blackwelder
John L. Rich

Clayton A. Moorson, Laramie, Wyoming.
S. H. Knight
Eliot Blackwelder
John L. Rich

William A. Burress, Tulsa, Oklahoma.
Sidney Powers
J. L. Gartner
Robert E. Garrett

William C. Kinkel, Tulsa, Oklahoma.
Burton Hartley
Sidney Powers
Robert C. Garrett

Ernest C. Moncrief, Arkansas City, Kansas.
J. V. Howell
F. L. Aurin
Glenn C. Clark

O. B. Wendeln, Pittsburgh, Pa.
Roswell H. Johnson
S. G. Huntley
R. E. Somers
Hugh L. Burchfiel, Berkeley, California.
Fred A. Davies
Jack M. Sickler
Irvine E. Stewart
Julian Q. Myers, Tulsa, Oklahoma.
Sidney Powers
George C. Matson
A. P. Wright
Frank T. Clark, Lexington, Kentucky.
H. E. Rothrock
E. Paul Rothrock
R. D. Reed
Charles R. Hoyle, Tulsa, Oklahoma.
S. Weidman
V. E. Monnett
O. F. Evans
Thomas B. Romine, Walla Walla, Washington.
L. R. Van Burgh
Walter A. English
J. M. Sickler
Gerald H. Westby, Denver, Colorado.
E. Eggleston Smith
Max W. Ball
R. Crandall

OBITUARY

ROLLIN D. SALISBURY

It is our sad duty to record the death of one of our most beloved and respected members, Dr. Rollin D. Salisbury, which took place in Chicago on August 15, 1922, as the result of a heart attack which overtook him

several months previously. Dr. Salisbury's death is peculiarly a loss to this Association, as almost ten percent of the total membership, exclusive of Associates, are graduates of the Department of Geology at the University of Chicago and therefore received their geological training under

his direction. Approximately one out of every three of the above men received Doctor's degrees in the department.

It is safe to say that each of our members who were his students feels a real personal bereavement in Dr. Salisbury's death. His passing marks to each the loss of a loyal friend and a competent adviser. His interest in his students continued beyond the termination of their college work and he followed the career of each with a fatherly concern. Their successes pleased him equally as much as though they were his own personal achievements. Without a family of his own, he reached out and bestowed on his favorite students the affection normally accorded to sons. He remarked to the writer shortly before his death that his greatest satisfaction in life lay in the ties of friendship and loyalty which bound such a large number of his former students to him.

Dr. Salisbury's chief interest lay in teaching and it is undoubtedly as a great teacher that he will be chiefly remembered. His original work in the field of geology was primarily concerned with studies of continental glaciation, prosecuted in his earlier years, and his more recent contributions were in the preparation of text books which are now standard throughout the colleges and universities of this country. During the last few months of his life he was engaged in a complete revision of the three-volume text book for advanced geological courses. At the time of his death, he was seriously contemplating taking advantage of his privelege of retirement, due at the end of another year of teaching, to prepare a volume designed to popularize the science of geology for the benefit of the layman; and he talked of yet another ambition to write a treatise on the climates of geological time. It is indeed a misfortune that one so eminently fitted for the task could not have lived to write these much needed books.

His methods of selecting students for his department were frequently unique. At the beginning of almost every school year he took a class of students for their beginning course in geology. Out of this class he usually selected a few individuals, whom he thought were qualified to make satisfactory geologists. He particularly delighted in making the course a perfect nightmare of rapid-fire questions for these select few, and if they stood up satisfactorily under the grilling, he took their breath away at the end of the Quarter with an invitation to dinner, during the course of which he encouraged them to continue with their work in geology. Thus students were occasionally, even frequently led to take up geology as a major subject when they had planned for themselves quite different careers. If personalities may be permitted here, the writer was thus early won away from an ambition to study law and was diverted to the field of geology.

Dr. Salisbury was a man of very positive character, of strong likes and dislikes. He positively could not tolerate an idler. If such a one inadvertently registered for his classes, he seldom received encouragement to continue beyond the first course. He ardently believed in the doctrine of hard work and religiously practiced it himself. This con-

tributed in no small degree to his untimely end. For the past few years his duties were so increased by the deanship of the Ogden Graduate School of science that his friends recognized he was overworking. Yet he persisted in carrying the entire burden of the administration of the department of geology and seldom delegated such duties to his assistants. His physician urgently insisted on his leading a less strenuous existence, but in spite of these warnings, he often worked in the library or in his

office at Rosenwald Hall until well past midnight. His health had not been robust for several years, and he was several times obliged to relinquish his teaching duties and resort to travel to recuperate.

He felt it his duty to remain at his post during part or all of the Summer Quarter, since at that time the student body of the University is composed largely of graduate students or teachers, and he was deeply interested in broadening the outlook of teachers on the science of geology. An interesting sidelight on his character was exhibited in his relations with these summer students, many of whom had returned to the University from teaching positions, to "brush up" on the natural sciences. He displayed a marvelous patience in answering their immature questions, and an unusual degree of courtesy, which was occasionally in

striking contrast to his petulance with younger students from whom he expected a greater degree of understandng.

To understand and fully appreciate the various angles of his character, it was necessary to know him for a period of years. To many who knew him casually, he remained a paradox. Because of his occasional gruff and abrupt manner, he earned for himself among undergraduates, the appelation of "the bear." But to those who succeeded in winning his approval, he was the most humane and kindly of men, although even to those whose friendship he prized most highly, he seemed at times unnecessarily gruff. When he threw off the duties of his office, he had the faculty of making himself the most agreeable and pleasant company, which fact was adequately attested by his great popularity at faculty and other social gatherings. His interest in and patience with children was one of his outstanding characteristics. Many a tiny youngster in the University community learned to wait expectantly, near the sidewalk for the pat on the shoulder and the few kindly words of greeting which inevitably came with his appearance. Surely there could be little meanness or narrowness in a character which could so readily win the approval and confidence of little children.

He was human, and being human, he had his frailties and short-comings, as all of us do. But now that he is gone, his true elements of greatness stand out in bold relief. The high regard in which he was generally held was evidenced at the funeral service by one of the most remarkable floral tributes ever witnessed at the University,—a huge bank of flowers from scientific societies, institutions of learning and individuals, which completely filled the end of Leon Mandel Hall. One wonders whether out of the developing generation, there will rise teachers of equal greatness. His death marks an irreparable loss to the University and to the teaching profession, a great personal loss to his host of friends, and he will surely survive in memory as one of the most effective and renowned geologists of the century.

W. E. WRATHER.

GUY HENRY COX

Dr. G. H. Cox, Chief Geologist for Josey Oil Company of Oklahoma City was fatally injured in an automobile accident on the night of August 19th and died without recovering consciousness at 3 A. M. August 20th.

When returning from work alone about eleven o'clock at night, evidently blinded by the bright lights on an approaching car, Dr. Cox drove over a steep embankment about a mile and a half north of Bristow, Oklahoma. His car, a Franklin, turned over and he was caught and crushed beneath the steering wheel The accident was discovered by passersby practically as soon as it occurred and Dr. Cox was promptly removed to a hospital in Bristow and medical aid administered but death resulted from hemorhage of the lungs at 3:00 A. M. Thus "passed on" one of the best known and most highly respected geologists.

Guy Henry Cox was born in the town of Lehigh, Webster County, Iowa, May 4th, 1881. His father Edward Henry Cox and mother Ada Wilson Cox were pioneer Iowa stock.

Guy Henry Cox attended public schools at Lehigh and later at Fort Dodge. After completing his public and High School education in 1901 at Fort Dodge he entered Northwestern University from which he graduated with B. S. degree in 1905. From 1905-1906 he was a gradu-

ate student in the School of Mines, University of California. It was during this training that Dr. Cox started an intensive study of mining geology. In 1906 he left California and entered the University of Wisconsin where he pursued his specialty, geology, and 1908 was a Fellow in Geology, under C. K. Leith and first started teaching in connection with his school work. Later he received a Ph.D. degree from Wisconsin University.

From the University of Wisconsin he returned to the University of California in 1908 where he remained until 1909 when he was called to fill the position of Assistant Professor of Mineralogy and Geology, Missouri School of Mines, Rolla, Mo. In 1911 Prof. Cox was made Head of De-

partment Geology, Missouri School of Mines which position he held until 1920.

Professor Cox was a man of high ideals and worked tirelessly to build up the department under him. That he was efficient as well as tireless is evidenced by the high rank the Geology department of Missouri School of Mines attained under his direction.

Dr. Cox was not content to be a highly successful teacher but had the rare quality of being able to combine the theoretical with the practical. Aside from his work as a teacher Dr. Cox under the firm name of Cox & Radcliffe established offices as Consulting Geologists in Tulsa, Oklahoma and also in Rolla, Missouri. In this work he personally directed geologic work in Oklahoma, Texas, Kansas, Arkansas and Louisiana. During 1920 Dr. Cox accepted a position as Chief Geologist, Josey Oil Company and spent practically his entire time in reconnoisance work having two or more detail parties constantly at work outlining areas favorable for oil production.

Dr Cox was also an author of note and contributed many valuable papers. Among them should be mentioned the following:

Copper in Southwestern Wisconsin. Mining & Scientific Press Vol. 99 No. 18 P. 529 - 1909.

Elizabeth Sheet of Lead and Zinc District of Northern Illinois. Ill. State Geol. Survey, Bull. 16 - 1909.

Lead and Zinc district of Northern Illinois, Mining World. Vol. 34 No. 8 - 1911.

Methods of Prospecting and Estimating ore bodies in the Wisconsin Zinc and Lead district. Missouri School of Mines and Metallurgy—Thesis for E. M. degree 1914, and

Geologic Criteria for determining the Structural Position of Sedimentary Beds. Missouri School of Mines & Metallurgy—Technical Series Vol. 2 No. 4 - 1916.

Dr. Cox's best work was his recent book prepared in collaboration with Professors Drake and Muilenberg of Missouri School of Mines entitled "Field Methods in Petroleum Geology." This book is the first in its field and contains a great many new and practical suggestions regarding the best practice in field examination of petroleum prospects.

Dr. Cox was an active members in the following technical societies:

American Institute of Mining & Metallurgical Engineers—1912.

American Association of Petroleum Geologists—1917.

Society for the Promotion of Engineering Education—1919.

The Geological Society of America—1920.

In addition to the above he was a Mason, and a member of Alpha Chi Sigma, (Chemical fraternity); Tau Beta Pi (Honorary Member); Beta. Mo. and Phi Kappa Phi (Charter Member) M. S. M. 1920. Being very actve, a thorough students and constructive thinker, Dr. Cox crowded into his life of 41 years an experience superior to that of many older men in the same profession.

Professor Cox was married to Kittie May Gates at Clear Lake, Iowa

on December 27th, 1909 shortly after he became Assistant Professor of Geology & Mineralogy, Missouri School of Mines. To this union were born a boy, Kenneth Dale, July 30, 1912, and a girl, Catherine Gates, May 18, 1914. Mrs. Cox and both children survive Dr. Cox.

I was privileged to be the first Assistant to Professor Cox when he came to Missouri School of Mines and can never forget his genuine hospitality, kindly interest and never-tiring effort to help and inspire his subordinates.

I am sure that the American Association of Petroleum Geologists feels, with his many other friends that Guy Henry Cox has left a memory of which we may well be proud.

V. H. McNutt.

AT HOME AND ABROAD

Chas. R. Fettke, Associate Professor of Geology and Mineralogy at Carnegie Institute of Technology, Pittsburgh,Pa., has completed an investigation of the oil resources of the coals and carbonaceous shales of Pennsylvania for the State Bureau of Topographic and Geological Survey.

Pierce Larkin, of Tulsa, has been working in Nebraska.

W. E. Wrather presented the University of Chicago with a tract of land near St. Genevieve, Missouri, where an important stratigraphic section is exposed, for the use of the summer school in geology.

A. W. McCoy located the Empire well in Sec. 31 T. 31 S., R, 7 E., Cowley Co., Kansas.

J. M. Sands located the Phillips Petroleum Co. well in Sec. 1, T. 23 S., R. 4 E., Butler Co., Kansas.

D. E. Winchester, Consulting Geologist of Denver, Colo., spent October in Oklahoma on professional work.

H. Harper McKee, of New York City, spent November in Northern Louisana.

W. C. Thompson, of the Sun Co., has been working at Smackover, Arkansas.

W. B. Emery, of the Ohio Oil Co., returned to Denver in October after spending the summer in Montana.

W. B. Wilson, of the Gypsy Oil Co., Tulsa, returned to Tulsa in October from the Sweetgrass Arch, Montana.

L. E. Kennedy, associated with R. B. Whiteside, has moved from Muskogee to Tulsa and is located in the Atlas Bldg.

Carl Beal, of San Francisco, has been in Washington representing the oil producers of California in tax matters.

W. A. English, of Los Angeles, is associated with the Standard Oil Co. of California and spent the summer in Montana.

R. Van A. Mills, of the Bureau of Mines, studied the faults of Salt Creek and Teapot Dome in October and November.

The Standard Oil Co. of California has invaded Texas under the name The California Co., and E. D. Lynton is in charge of the work at Abilene, Texas.

C. A. Hartnagel, Assistant State Geologist of New York, is preparing a bulletin on restoring pressure in the oil sands of western New York.

H. F. Crooks is working in northern Africa.

S. A. JUDSON, of Tulsa, is working in northern Texas.

L. E. ENGLISH is associated with Foster & Reiter.

L. G. KEPPLER is Chief Geologist of the Southwestern Petroleum Co., of Tulsa.

W. E. WRATHER returned to 6044 Bryan Parkway, Dallas, in September.

A. O. HAYES is working for the Standard Oil Co. of N. J. at Comodoro Rivadavia, Argentina.

F. B. PLUMMER is agent for the Dutch Shell at Houston.

W. L. GOLDSTON and LEON RUSS represent the U. S. Tex. Oil Co. in Texas.

J. M. SANDS is in charge of the land department of the Phillips Pet. Co. at Bartlesville.

DEAN STACEY, of Oklahoma City, has been in Denver on professional business.

C. P. BERKEY is examining the oil possibilities of Mongolia.

J. E. ELLIOTT and F. C. MERRITT published a paper, "Core drilling in oil fields of Southern California," in Summary of Operations, California Oils Fields, for July.

VICTOR E. GOTHE, of the Pure Oil Co., recently returned from Columbus to Caracas, Venezuela.

MEMBER LIST

OF AMERICAN ASSOCIATION OF PETROLEUM GEOLOGISTS

Active Members

Abrahmson, Hjalmar, Box 1227, Denver, Colo.
Absher, William F., Norman, Oklahoma.
Adams, George Irving, University, Alabama.
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Adams, H. H., 415 W. T. Waggoner Bldg., Fort Worth, Texas.
Adams, Noah C., 1006 Mayo Bldg., Tulsa, Oklahoma.
Adkins, W. S., Apartado 150, "El Aguila," Tampico, Mexico.
Adrian, H., "La Carona" Apartado 238, Tampico, Mexico.
Ainsworth, William L., 301 North Yale Street, Wichita, Kansas.
Albertson, Maurice M., Roxana Petroleum Corp., Haynesville, Louisiana.
Allen, E. G., Arcade Building, St. Louis, Missouri.
Allen, Herman J., 225 Quentin Ave., Wichita, Kancas.
Allen, Walter Joseph, 505 Elliott Street, Wilkinsburg, Pennsylvania.
Alvey, Glenn H., 526 Elizabeth Street, Beaumont, Texas.
Ambrose, A. W., Bureau of Mines, Washington, D. C.
Ames, Edward W., Box 691, Fort Worth, Texas.
Anderson, Amil A., 415 Foster Bldg., Denver Colorado.
Anderson, Carl Bernard, 42 Broadway, New York City.
Anderson, J. G., Jr., 1402 Cleburne Ave., Houston, Texas.
Andresen, Lewis Paul, 179 South Lafayette Street, Denver, Colorado.
Andrews, Sylvan H. Box 57, Okmulgee, Oklahoma.
Applin, Paul Livingston, Rio Bravo Oil Co., Houston, Texas.
Armstrong, J. M., Box 1263, Ponca City, Oklahoma.
Arnold, Ralph, 639 South Spring Street, Los Angeles, California.
Ashley, George H., State Capitol, Harrisburg, Pennsylvania.
Augur, Irving V., 827 Story Bldg., Los Angeles, California.
Aurin, Fritz, Marland Co., Ponca City, Oklahoma.

Baird, Chester A., Puerto Mexico, Ver., Mexico, Apartado 86.
Baker, Charles L. 10 Mosswood Road, Berkeley, California.
Baker, Raymond F., The Texas Co., Houston, Texas.
Baldwin, H. L., Box 1447, Bartlesville, Oklahoma.
Baldwin, Harry L., Jr., 1512 Maple Street, Golden, Colorado.
Ball, Max W., 1104 First National Bank Bldg., Denver, Colorado.
Ball, Sidney H., Room 1414, 42 Broadway, New York City.
Barbour Erwin Hinckley, University of Nebraska, Lincoln, Nebraska.
Barrow, Leonidas T., University of Texas, Austin, Texas.
Barton, Donald C., Box 1817, Houston, Texas.
Barton, Louis A., 250 East College Street, Oberlin, Ohio.
Bartram, John G., Box 749, Ardmore, Oklahoma.
Bateman, Alan M. Drawer C, Yale Station, New Haven, Connecticut.
Bates, Mowry, Lindsay, California.
Bauer, C. Max, Box 1308, Billings, Montana.
Beal, Carl H., 407 Merchants Nat'l Bank Bldg., San Francisco, California.
Bean, Ward C., Box 1022, Fort Worth, Texas.
Beck, Elfred Box 157, Billings, Montana.
Becker, Clyde M., Moran, Kansas.
Beckwith, Henry T., Box 1052, Bartlesville, Oklahoma.
Beede, J. W., 1711, San Antonio Street, Austin, Texas.
Beekly, Albert L., Box 2024, Tulsa, Oklahoma.
Bell, Harry Wesley, 411 Insurance Bldg., Dallas, Texas.
Bell, Robert N., Box 1339, Boise, Idaho.
Bendrat, Thomas A., Box 833, De Land, Florida.

Bennett, Clyde M., Louisiana Oil Refining Corp., Shreveport, Louisiana.
Bennett, Holly R., Drawer 1062, Dallas, Texas.
Benton, Louis B., Humble Oil Co., Ardmore, Okla.
Berger, Walter R., 204 South Osage Street, Ponca City, Oklahoma.
Bernard, W. E., Box 2044, Tulsa, Oklahoma.
Bevier, George M., 703 Pecore St., Houston, Texas.
Bierman, Alfred C., Room 1409, 170 Broadway, New York City.
Birk, Ralph A., Box 299, Ardmore, Oklahoma.
Blackwelder, Eliot, Stanford University, California.
Blanchard, W. G., Box 702, Hominy, Oklahoma.
Bleecker, Edward S., Room 711, Battery Park Bldg., New York City.
Bloesch, Edward, 721 Kennedy Bldg., Tulsa, Oklahoma.
Borries, W. J., 33 Keryon Bldg., Louisville, Kentucky.
Bossler, Robert B., Forest County, Lynch, Pennsylvania.
Bostick, J. Wallace, Box 361 Tulsa, Oklahoma.
Bosworth, Thomas Owen, 12 St. Giles Street, Northampton, England.
Bowen, Charles Franklin, Room 322, 26 Broadway, New York City.
Bowen, James P., Temple, Oklahoma.
Bowman, Wayne F., Rio Bravo Oil Co., Houston, Texas.
Boyd, Harold Edward, Room 1201, 60 Wall St., New York City.
Boylan, Ebert E., Box 525, Edmond, Oklahoma.
Brace, Orval L., 1814 South Princeton St., Glendale, Californai.
Bradish, Ford, Box 638, Okmulgee, Oklahoma.
Brainerd, Arthur E., Empire Gas & Fuel Co., Bartlesville, Oklahoma.
Branner, George C., 703 A. O. U. W. Bldg., Little Rock, Arkansas.
Brantly, John Edward, Apartado 483, Tampico, Mexico.
Brokaw, Albert D., 157 Maplewood Ave., Maplewood, New Jersey.
Broman, Isidore J., Atlantic Producing Company., Oklahoma City, Okla.
Brown, J. Earle, 625 East Quincy St., San Antonio, Texas.
Brown Robert Wesley, Room 5013 Interior Bldg., Washington, D. C.
Browning, Iley B., 612 E. Lexington Ave., Ashland, Kentucky.
Bruyere, Alan, Apartado 191, Tampico, Mexico.
Bryan, Frank, 906 Petroleum Bldg., Tulsa, Oklahoma.
Buehler, H. A., Rolla, Missouri.
Burg, Robert S., 1316 W. T. Waggoner Bldg., Fort Worth, Texas.
Burleigh, William Porter, 5405 Dorchester Ave., Chicago, Ill.
Burnett, Jerome B., Apartado 86 Puerto Mexico, El Aguila, Vera Cruz, Mexico.
Burress, Walter M., Tonkawa, Oklahoma.
Burt, Roy Allen, Box 10, Independence, Kansas.
Burton, George E., Arcade Building, St. Louis, Missouri.
Burtt, John Gurney, 806 Coutra Costa Road, Berkeley, California.
Bush, Reed D., Empire Gas & Fuel Co., ElDorado, Kansas.
Butters, Roy M., Apartado 755, Tampico, Mexico.
Butterworth, E. M., 616 Standard Oil Bldg., San Francisco, California.
Buttram, Frank, 601 West 14th St., Oklahoma City, Oklahoma.
Buttram, Wm. A., 313 Mercantile Bldg., Oklahoma City, Oklahoma.
Bybee, H. P., University Station, Austin, Texas.

Cadman, Wilson K., 155 Washington Ave., Edgwood, Pittsburgh, Pennsylvania.
Cady, Gilbert H., University of Arkansas, Fayetteville, Arkansas.
Calvert, W. R., 715 Newhouse Bldg., Salt Lake City, Utah.
Carlton, Dave P., Box 400, Cisco, Texas.
Carney, Frank, Box 67, Fort Worth, Texas.
Carpenter, Everett, 1402 East Fourth Ave., Winfield, Kansas.
Cashin, D'Arcy M., Humble Oil & Refining Co., Houston, Texas.
Caudill, Samuel J., 801 Cosden Bldg., Tulsa, Oklahoma.
Cavins, Omar A., 200 Bush St., San Francisco, California.
Chapman, Lewis C., 908 Humble Bldg., Houston, Texas.
Chase, James L., 315 East Amerige St., Fullerton, California.

Cheney, Charles A., Burlington, Kansas.
Cheney, M. G., Box 575, Graham, Texas.
Clapp, Frederick G., Suite 2055, 30 Church St., New York City.
Clark, Chester C., Roxana Corp., Sinclair Bldg., Shreveport, La.
Clark, Clifton W., 3734 Spence St., Dallas, Texas.
Clark, Frank R., Box 131, Sistersville, West Virginia.
Clark, Glenn C., Marland Oil Co., Ponca City, Oklahoma.
Clark, R. W., McBrayer Bldg., Okmulgee, Oklahoma.
Clark, Stuart K., Box 902, Okmulgee, Oklahoma.
Clarke, Archibald D., Box 188, Duncan, Oklahoma.
Clarke, Carl W., Box 336, Okmulgee, Oklahoma.
Cline, Justus H., Stuarts Draft, Virginia.
Clinkscales, Albert S., 209 South Nogales St., Tulsa, Oklahoma.
Closuit, E. M., Box 988, Wichita Falls, Texas.
Coats, Charles M., Box 1116-17, Wichita, Kansas.
Collingwood, Douglas M., State Geological Survey, Urbana, Illinois.
Collom, Roy E., 920 Fresno Ave., Berkeley, California.
Condit, D. Dale, Whitehall Petr. Corp., Ltd., 15 Lawrence, Road, Lahore, India.
Conkling, R. A., North American Oil Co., Colcord Bldg., Oklahoma City, Okla.
Cook Harold J., Agate, Nebraska.
Corbett, Clifton S., 1201 Oread Apts., Lawrence, Kansas.
Coryell, Lewis S., Phillips Petroleum Co., Bartlesville, Oklahoma.
Crebbs, Chester M., Apartado 106, Tampico, Mexico.
Crider, A. F., 821 Ontario St., Shreveport, Louisiana.
Cullen, John, 2100 N Street, N. W., Washington, D. C.
Cutler, Willard W., Jr., U. S. Bureau of Mines, Bakersfield, Calif.

Dalburg, Frank A., West India Oil Co., Caracas, Venezuela, S. A.
Dallas, Orlan L., 311 Woodlea Apts., Fort Worth, Texas.
Dally, Claude F., 2004 West 15th St., Oklahoma City, Oklahoma.
Dangerfield, Albert N., Riverside, California, Box 413.
Darnell, James L., 170 Broadway, New York City.
Davies, Fred A., 601 Third Ave., North, Great Falls, Montana.
Davis, Elmer F., Geology Dept., Shell Co., 343 Sansome St., San Francisco, Calif.
Davis, Ralph E., Room 902, Peoples Gas Bldg., Pittsburgh, Pa.
Davis, Robert J., Box 1266, Okmulgee, Oklahoma.
Dawson, L. Ray, 328 Liberty Nat'l. Bank Bldg., Oklahoma City, Okla.
Day, Clarence O., 617 Edwards St., Shreveport, Louisiana. .
Dean, David, 2823 East 5th St., Tulsa, Oklahoma.
Dean, Paul, Box 1109, Dallas, Texas.
Decius, Courtney, Address not known.
Decker, C. E., 508 Chautauqua Ave., Norman, Oklahoma.
De Golyer, E., 65 Broadway, New York City.
De Loys, Francois, Bataafsche Petroleum Co., The Hague, Holland.
De Wolf, Frank Walbridge, 708 South Busey St., Urbana, Ill.
Deussen, Alexander, 504 Stewart Bldg., Houston, Texas.
Dickie, W. E., Webster Groves, Missouri.
Dissinger, Earl, Apartado 1390, Tampico, Mexico.
Dixon, A. F., Room 2229, 120 Broadway, New York City.
Dobbin, Carroll E., U. S. Geological Survey, Washington, D. C.
Dobbins., Charles N., Yadkinville, North Carolina.
Dodge, William E., 315 West Highland Ave., Shawnee, Oklahoma.
Dolman, Phil B., Box 2045, Tulsa, Oklahoma.
Donnelly, L. G. 315 Burns St., Forest Hills, Long Island, N. Y.
Donoghue, David, 701 Burkburnett Bldg., Fort Worth, Texas.
Donovan, Percy W., 710 Security Bldg., Minneapolis, Minn.
Dorchester, Charles M., Box 107, Shreveport, Louisiana.
Dott, Robert H., Box 2045, Tulsa, Oklohoma.
Doub, Charles O., Foster & Reiter, Magnolia Bldg., Dallas Texas.

Dovre, Adolph O., Apartado de Correos 34, Maracaibo, Venezuela.
Drake, N. F., Fayetteville, Arkansas.
Dreher, Otto, Bataafsche Petroleum Co., The Hague, Holland.
Dresser, Myron A., Eberly & Stebinger, Avenida de Mayo 560, Buenos Aires, Arg.
Drummond, Wallace G., Bryce Bldg., O'Keefe & Collett, Fort Worth, Texas.
Duce, James T., The Texas Co., 17 Battery Place, New York City.
Dunlevy, Robert B., 1601 East 7th Ave., Winfield, Kansas.
Duston, Arthur W., Box 1343. Okmulgee, Oklahoma.

Easton, H. D., 304-6 Ardis Bldg., Shreveport, Louisiana.
Eaton, Arthur, Room 1409, 170 Broadway, New York City.
Eaton, Clayton H., Sanderson Hotel, Enid, Oklahoma.
Eckes, Charles R., Suite 2832, 17 Battery Place, New York City.
Edson, Dwight J., Box 927, Mexia, Texas.
Edson, Fanny C., 755 De Barr Ave., Norman, Oklahoma.
Edson, Frank A., 755 De Barr Ave., Norman, Oklahoma.
Edwards, Orrin M., 1021 East 6th St., Tulsa, Oklahoma.
Eirich, Constance G., Box 2044, Tulsa, Oklahoma.
Ekblaw, W. Elmer, 711 West Nevada St., Urbana, Ill.
Elledge, George A., Apartado 216, Tampico, Mexico.
Elliott, John E., 1016 Calif. Bldg., 205 S. Broadway, Los Angeles, Cal.
Ellisor, Miss Alva C., Humble Oil & Refining Bldg., Houston, Texas.
Ely, Fred B., 82 Ave des Champs, Elysees, Paris, France.
Emmons, Wm. H., University of Minnesota, Minneapolis, Minn.
Emrick, Eggleston B., 1220 Main St., Grand Junction, Colorado.
English, Leon E., 806 Atlas Bldg., Tulsa, Oklahoma.
English, Walter A., 1546 Manhattan Place, Los Angeles, California.
Erni, Arthur, Olten, Fiohheimstr 11, Switzerland.
Estabrook, Edward L., Midwest Refining Co., Casper, Wyoming.
Evans, Oren F., 810 Monnet St., Norman, Oklahoma.

Fath, A. E., U. S. Geological Survey, Washington, D. C.
Fees, L. V., Box 2100, Denver, Colorado.
Ferguson, John L., 816 Colcord Bldg., Oklahoma City, Okla.
Ferguson, R. N., 339 North Third St., San Jose, California.
Fettke, Charles R., Carnegie Institute of Technology, Pittsburgh, Pa.
Filmer, Edwin A., 44 Conklin Ave., Binghamton, New York.
Finch, Elmer H., Texas Oil Co., Houston, Texas.
Fisher, Cassius A., 711 First Nat'l, Bank Bldg., Denver, Colorado.
Fischer, Dr. O., 721 Kennedy Bldg., Tulsa, Oklahoma.
Fohs, F. Julius, 60 Broadway, New York City.
Foley, Lyndon L., Box 526, Okmulgee, Oklahoma.
Folger, Anthony, Box 912, Abilene, Taylor County, Texas.
Ford, Carl S., Box 756, Enid, Oklahoma.
Forrester, George A., 421 Board of Trade Bldg., Wichita, Kansas.
Foster, Walter L., University of Tulsa, Tulsa, Oklahoma.
Foster, William H., 1904 Magnolia Bldg., Dallas, Texas.
Freedman, Louis H., 701 Burkburnett Bldg., Fort Worth, Texas.
Franklin, Louis, Mid-Kansas Oil & Gas Co., Mineral Wells, Texas.
Friend, Russell D., 1646 Mass. St., Lawrence, Kansas.
Froyd, Erwin A., Box F., Salt Creek, Wyoming.
Fuqua, H. B., Box 988, Wichita Falls, Texas.
Fyfe, Douglas, 724 S. Spring St., Los Angeles, California.

Galbraith, Thomas J., 608 Standard Oil Bldg., San Francisco, California.
Galpin, S. L., Iowa University, Ames, Iowa.
Gardner, James H., 121 East Sixth St., Tulsa, Oklahoma.
Garfias, Valentine R., c-o H. L. Doherty & Co., 60 Wall St., New York City.
Garner, Aubrey H., 120 Broadway, New York City.

Garnjost, Frederick W., Spuyten Duyvil, New York City.
Garrett, Dan L., 5th Floor, Colcord Bldg., Oklahoma City, Oklahoma.
Garrett, Lovic P., Drawer 1791, Houston, Texas, Gulf Production Co.
Garrett, Melvin M., 1011 City Nat'l. Bank Bldg., Wichita Falls, Texas.
Garrett, Robert E., 906 Petroleum Bldg., Riverland Oil Co., Tulsa, Oklahoma.
Garrett, S. G., Box 1011, Oklahoma City, Oklahoma.
Gartner, James L., Box 1748, Tulsa, Oklahoma.
Gaylord, E. G., 79 New Montgomery St., San Francisco, Calif.
Gester, George C., 617 Standard Oil Bldg., San Francisco, Calif.
Gester, Stephen H., 607 Standard Oil Bldg., San Francisco, Calif.
Getzendaner, Frank M., Humble Co., Uvalde, Texas.
Geyer, F. Park, Marland Oil Co., Ponce City, Oklahoma.
Giffin, Wilson C., General Oil Co. of California, Apt. 652, Tampico, Mexico.
Giles, Albert W., Box 298, University, Va.
Glenn, L. C., Vanderbilt University, Nashville, Tennessee.
Goldston, Walter L., Jr., Box 379, Bartlesville, Oklahoma.
Goodrich, Harold B., 111 West Fourth St., Tulsa, Oklahoma.
Goodrich, Robert D., Magnolia Bldg., Dallas, Texas.
Gordon, Dugald, Sinclair Oil & Gas Co., Tulsa, Okla.
Gordon, Wallace, Gordon Home Place, Azusa, California.
Gouin, Frank Box 428, Duncan, Oklahoma.
Gould, Charles N., 1218 Colcord Bldg., Oklahoma City, Okla.
Graham, Edwin S., Graham, Texas.
Grant, U. S., Northwestern University, Evanston, Illinois.
Gray, Alfred, Atlantic Prod. Co., Dallas, Texas.
Grebin, Frederick C., T. S. Taliferro, 1st Nat'l. Bank, Houston, Texas.
Greene, Frank C., Box 462, Tulsa, Oklahoma.
Green, George L., Apartado 31, Panuce, Vera Cruz, Mexico.
Griswold, Clyde T., 1011 Tradesmens' Bank Bldg., Oklahoma City, Oklahoma.
Gunter, Herman, 715 E. Virginia St., Tallahassee, Florida.

Hager, Dilworth S., Box 1791, Houston, Texas.
Hager, Dorsey, 4th Floor Guaranty Bldg. 44th & 5th Ave., New York City.
Hager, Lee, 502 Beatty Bldg., Houston, Texas.
Hall, Roy H., Bureau of Mines, Rolla, Missouri.
Hamilton, Charles W., Apartado 106, Tampico, Tamps., Mexico.
Hamilton, H. L. Box 657, Orange, Texas.
Hamilton, W. R., Box 1112, Tulsa, Oklahoma.
Hammer, Alva A., Sinclair Oil & Gas Co., 524 Securities Bldg., Billings, Montana.
Hammill, Chester A., 1417 American Exchange Bank Bldg., Dallas, Texas.
Hance, James H., State Geological Survey, Urbana, Ill.
Hans, Oscar E., 305 Atco Bldg., Tulsa, Oklahoma.
Harnsberger, T. K., Drawer 312, Tulsa, Oklahoma.
Harrison, Thomas T., 1000 First Nat'l. Bank Bldg., Denver, Colorado.
Hartley, Burton, 206 South Cheyenne, Tulsa, Oklahoma.
Hartman, Adolph E., 1108 W. T. Waggoner Bldg., Fort Worth, Texas.
Hawley, James E., Whitehall Petr. Corp., 15 Lawrence Road, Lahore, India.
Haworth, Erasmus, 1503 Mass. St., Lawrence, Kansas.
Huntsman, Haworth, Box 955, El Dorado, Kansas.
Hayes, A. O., 812 D Avenue, Coronado, California.
Hayes, Reeve L., 310 South Frisco, Tulsa, Oklahoma.
Haynes, Winthrop P., 74 Beacon St., Hyde Park, Boston 36, Mass.
Hazeltine, R. S., Sterling Oil & Refining Co., Wichita, Kansas.
Heald, Kenneth C., U. S. Geological Survey, Washington, D. C.
Heaton, R. L., 2374 Elm St., Denver, Colorado.
Heidenreich, W. L., 4000 South Benton, Kansas City, Missouri.
Hendon, Gryan, 1129 North Beard St., Shawnee, Oklahoma.
Hendry, Barbara A., 806 Osage Ave., Bartlesville, Okla.
Henley, A. S., 417 Carter Bldg., Houston, Texas.

Hennen, Ray V., Room 1604, Benedum-Trees Bldg., Pittsburgh, Pa.
Henninger, Waldemar F., 1109 California Ave., Houston, Texas.
Henning, John L., Box 868, Lake Charles, Louisiana.
Henry, Wm. W., Box 341, Tulsa, Oklahoma.
Herald, Frank A., Cias del Agwi, Apartado 76, Tampico, Tamps., Mexico.
Herald, J. M., 7204 Lindell Ave., St. Louis, Missouri.
Herold, Stanley C., 5729 Holden St., Pittsburgh, Pa.
Heroy, William B., 19 Wayne Ave., White Plains, N. Y.
Hill, Benjamin F., Cripple Creek, Colo.
Hill, Robeht T., Magnolia Bldg., Dallas, Texas.
Hindes, E. P., Box 389, Bartlesville, Oklahoma.
Hinds, Henry, 1153 Laurel Ave., St. Paul, Minn.
Hintze, F. F., 300 California Bldg., Denver, Colo.
Hodge, Edwin T., 1522 Standard Bank Bldg., Vancouver, B. C.
Hoffman, Charles C., Empire Oil Co., Bartlesville, Okla.
Holden, William J.. Parkersburg, W. Va.
Holman, Eugene, Box 198, Shreveport, La.
Honess, Charles W., Oklahoma Geological Survey, Norman. Okla.
Hoover, James E., 432 Mayo Bldg., Tulsa, Oklahoma.
Hopkins, Edwin B., 25 Broadway, New York City.
Hopkins, Oliver B., Imperial Oil Co., 56 Church St., Toronto, Canada.
Hopper, Walter E., Brazos River Oil Corp., 520½ Spring St., Shreveport, La.
Horn, Carl G., 904½ West 12th St., Oklahoma City, Okla.
Howell, Jesse V., Old Science Hall, Iowa City, Iowa.
Howell, Willie F., Phillips Petroleum Co., Bartlesville, Okla.
Hubbard, William E., Humble Oil Co., Ardmore, Oklahoma.
Hughes, C Don, Box 13, El Dorado, Kansas.
Hughes, Richard, 902 Cosden Bldg., Tulsa, Oklahoma.
Hughes, Urban B., Box 445, Magnolia, Arkansas.
Hughes, V. H., 406 Exchange Nat'l Bank Bldg., Tulsa, Okla.
Huguenin, Emile, State Mining Bureau, Taft, California.
Hull, Joseph P. D., Louisiana Oil Refining Corp., Shreveport, La.
Hummel, E. W., Eaton & Loomis, American Natl't Bank Bldg., Oklahoma City, Ok.
Huntley, Louis G., 504 Frick Bldg., Pittsburgh, Penn.
Hutchinson, L. L., Box 1515, Kennedy Bldg., Tulsa, Okla.

Iddings, Arthur, Apartado 170, Cartagena, Columbia.
Irwin, Joseph S., Box 1739, Casper, Wyoming.

Johnson, Carlyle D., 3114 Paseo, Kansas City, Missouri.
Johnson, Frederick A., 141 South Bryant Ave., Bellevue, Penn.
Johnson, Roswell H., 1039 Murrayhill Ave., Pittsburgh, Penn.
Jones, Edward L., Jr., Box 1263, Ponca City, Oklahoma.
Jones, James J., 301 Guthrie Ave., Tulsa, Okla.
Justice, Philip S., Drawer 790, Sun Co., Beaumont, Texas.

Kautz, Archie R., Empire Gas & Fuel Co., Bartlesville, Okla.
Kay, Fred H., Apartado "I", Caracas, Venezuela, c-o Venezuelan Sun, Ltd.
Keeler, Clifton M., Room 5009, Interior Bldg., Washington, D. C.
Kemp, James F., Schemmerhorn Hall, Columbia University, New York City.
Kendrick, Frank E., Lone Star Gas Co., Dallas, Texas.
Kennedy, Luther E., 404 Atlas Life Bldg., Tulsa, Oklahoma.
Kennedy, Wm., American Exchange Nat'l Bank Bldg., Dallas Texas.
Keppler, Leo G., 624 North Boulder St., Tulsa, Okla.
Kernan, Thomas H., Apt. 150, Tampico, Tamps., Mexico.
Kerr, John B., Box 1094, Shreveport, La.
Kesler, L. W., 1305 East 9th St., Winfield, Kansas.
Kew, Wm. S. W., 901 South Norton Ave., Los Angeles, Calif.
Kimball, Kent K., U. S. Geological Survey, Washington, D. C.

Kirby, Grady, Box 564, San Antonio, Texas
Kirk, Charles T., 432 Mayo Bldg., Tulsa, Okla.
Kirwan, Matthew J., Bureau of Mines Bartlesville, Okla.
Kite, William C., 301-3 Baum Bldg., Oklahoma City, Okla.
Kitson, Howard W., 337 East Seaside Blvd., Long Beach, Calif.
Klein, William C., 30 Carel v. Bylandtlaan, The Hague, Holland.
Knapp, Arthur, Box 1902, Philadelphia, Penna.
Knapp, G. N., 905 Burkburnett Bldg., Fort Worth, Texas.
Knappen, Russell S., 1021 Maine St., Lawrence, Kansas.
Kniker, Hedwig T., Geological Dept., The Texas Co., Houston, Texas.
Knight, Samuel H., University of Wyoming, Laramie, Wyoming.
Knox, John K., 15 Lawrence Road, Lahore, India.
Koto, Prof. B., Imperial University, Tokio, Japan.
Kraus, Edgar, 2103 McKinney Ave., Houston, Texas.
Kupferstein, Joseph T., 8661 - 24th Ave., Bensonhurst, Brooklyn, N. Y.

La Croix, Morris F., 82 Devonshire St., Boston, Mass.
Lahee, Frederick H., The Sun Co., Amer, Exch. Nat'l Bank Bldg., Dallas, Texas
Laird, B. Leo, Apartado 64 Bis, Mexico, D. F.
Le Neve, R. O., Wylie Bldg., Mineral Wells, Texas.
Lasky, Bernard H., Atco Bldg., Tulsa, Okla.
Laskey, Glenn E., 206 Sinclair Bldg., Shreveport, La.
Lauer, Arnold W., c-o Carter Oil Co., Tulsa, Oklahoma.
Lee, Marvin, 521 Union Nat'l Bank Bldg, Wichita, Kansas.
Lee, Wallace, c-o Commissioner General, Royal Railway Dept., Bankok, Siam.
Leibensperger, Raymond, Apartado 657, Tampico, Mexico.
Lemley, G. C., Box 1470, Tulsa, Oklahoma.
Levorsen, A. Irving, 1335 East 8th St., Okmulgee, Okla.
Lewis, James O., First Nat'l Bank Bldg., Marietta, Ohio.
Ley, Henry A., Southwestern Gas Co., Independence, Kansas.
Liddle, Ralph A., Room 621, 18 Broadway, New York City.
Lilligren, J. M., Box 107, Duncan, Okla.
Lilly, Eugene, Endicott Bldg., St. Paul, Minn.
Lindeblad, E. E., 527 New Masonic Bldg., Bartlesville, Okla.
Link, Theodore A., 530 Tegler Bldg., Imperial Oil Co., Ltd., Edmonton, Alberta.
Lloyd, E. Russell, Box 105, Mineral Wells, Texas.
Loel, Wayne, 1025 Stock Exchange Bldg., Los Angeles, Calif.
Logan, Clarence Z., 1515 - 16th St., N. W., Washington, D. C.
Longmire, William R., Address not known.
Longyear, Robert D., 710 Security Bldg., Minneapolis, Minn.
Loomis, Harve, 812-13 Amer. Nat'l Bank Bldg., Oklahoma City, Okla.
Lounsbery, Dean E., Potter, N. Y.
Lowe, Ephraim N., Old Capital, Jackson, Miss.
Lowe, H. J., Address not known.
Lupton, Charles T., 617 Gilpin St., Denver, Colo.
Lyon, F. Russell, 309 New Masonic Bldg., Bartlesville, Okla.
Lyons, Richard T., c-o Sinclair Oil & Gas Co., Box 2026, Tulsa, Okla.

MacKay, Bertram R., c-o Whitehall Petr. Corp., 15 Lawrence Road., Lahore, India.
MacKay, Hugh, 216 South Oak St., Sapulpa, Okla.
MacKenzie, Andrew N., Box 1859, Casper, Wyoming.
Macready, George A., 614 South Carondelet St., Los Angeles, Calif.
Mac Donald, Donald F., Room 2300, 45 Nassau St., New York City.
Manning, Van H., American Petroleum Institute, 15 West 44th St. New York City.
Markham, Edmond O., Box 2045, Tulsa, Oklahoma.
Marsters, Vernon F., 5th Floor, Hayes Bldg., 920 Grand Ave., Kansas City, Mo.
Mason, Shirley L., 5554 Avondale Pl., Pittsburgh, Penna.
Mather, Kirtley F., Granville, Ohio. Denison University.
Matson, George C., Box 2044, 1507 South Main St., Tulsa, Oklahoma.

Matteson, Wallace G., Box 376, Center Moriches, Long Island, N. Y.
May, Arthur R., Box 596, Santa Maria, Calif.
McCallie, Samuel W., Geological Survey, Atlanta, Georgia.
McCollough, A. Stafford, Box 111, Clifton, Green County, Ohio.
McCoy, Alexander W., Box 379, Bartlesville, Oklahoma.
McCrary, E. W., Box 790, Tulsa, Oklahoma.
McCluer, R. D., Box 742, Corsicana, Texas.
McFarland, R. S., Twin State Oil Co., Tulsa, Oklahoma.
McGowan, James J., Caixa Postal 315, Loanda, Angola, Africa.
McIntyre, Paul J., Phillips Petroleum Co., Bartlesville, Okla.
McKanna, Edwin A., Apartado 162, Tampico, Tamps., Mexico.
McKee, H. Harper., 120 Broadway, New York City.
McLaughlin, R. P., 315 Montgomery St., San Francisco, Calif.
McLellan, Hiram J., Humble Oil & Refining Co., Houston, Texas.
McLeod, Angus, 206 Sinclair Bldg., Shreveport, La.
McNutt, Vachel H., 210 South Cheyenne St., Tulsa, Oklahoma.
McWhirt, Burr, 1022-23 Stock Exchange Bldg., Los Angeles, Calif.
Melcher, A. F., 4115 Emery Place, N. W., Washington, D. C.
Mendenhall, Walter C., U. S. Geological Survey, Washington, D. C.
Meredith, Carlton, Great Southern Life Bldg., Dallas, Texas.
Merritt, J. W., F. W. Freeborn Engineering Corp., Mayo Bldg., Tulsa, Okla.
Milek, Andrew, Room 23 Bertani Bldg., Laredo, Texas.
Millard, William J., 217 Lynch Bldg., Tulsa, Okla.
Miller, Arthur M., University of Kentucky, Lexington, Ky.
Miller, John C., 2105-A Ann Ave., St. Louis, Mo.
Miller, Wendell Z., Box 2044, Tulsa, Oklahoma.
Miller, Willard L., 2505 West 10th St., Oklahoma City, Okla.
Millikan, Charles V., Box 57, New Madison, Ohio.
Mills, R. Van A., U. S. Bureau of Mines, Washington, D. C.
Minor, H. E., Gulf Producing Co., Houston, Texas.
Mix, Sidney E., 261 Dalzell St., Shreveport, Louisiana.
Monnett, V. Elvert, 123 White St., Norman, Okla.
Montgomery, H. R., 208 Nat'l Bank Bldg., Muskogee, Okla.
Moody, Clarence L., 316 Commercial Bank Bldg., Shreveport, La.
Moore, Raymond C., University of Kansas, Lawrence, Kansas.
Moran, Robert B., 215 West 7th St., Los Angeles, Calif.
Morgan, George D., Box 924, Ada, Okla.
Morgan, Glenn B., State Geologist, Cheyenne, Wyoming.
Morley, Harold T., Box 1075, Casper, Wyoming.
Morris, A. F., Box 1991, Tulsa, Okla.
Morse, William C., Agricultural College, Mississippi.
Moyer, W. Irwin, 3525 Forbes St., Pittsburgh, Penna.
Munn, Malcom J., Cosden Bldg., Tulsa, Okla.
Mylius, L. A., State Geological Survey, Urbana, Ill.

Naramore, Chester, 464 Riverside Drive, Apt. 72, New York City.
Nash, Howard F., Apartado 285, Tampico, Mexico.
Nelso, Walter S., Box 1227, 518-28 U. S. Nat'l Bank Bldg., Denver, Colo
Neumann, L. Murray, Box 245, Carter Oil Co., Tulsa, Okla.
Nelson, Wilbur A., Capitol Annex, Nashville, Tenn.
Nevin, Charles M., Geology Dept., Cornell University, Ithaca, N. Y.
Newby, Jerry B., 519 West 4th St., Oklahoma City, Okla.
Newby, Warner W., 110 North Eighth St., Ponca City, Okla.
Nichols, Charles R., Apartado 85, Maracaibo, Venezuela, S. A.
Nickell, C. O., The Texas Co., Wichita Falls, Texas.
Nisbet, John M., Empire Co., Bartlesville, Okla.
Noble, Homer A., 2743 Maryland Ave, Baltimore Md.
Nolan, Edward D., General Petroleum Corp., Alaska Commercial Bldg., San Francisco, California.

Norton, Geo. H., 205 W. Monroe St., Chicago, Ill.
Notestein, Frank B., Box 295, Wooster, Ohio.
Nowlan, Harry H., Box 1301, Bradstreet Oil Co., Tulsa, Okla.

Officer, Herbert G., Twin State Oil Co., Tulsa, Okla.
Ohern, D. W., 515 West 14th St., Oklahoma City, Okla.
Olsson, Axel A., 48 Woodside Ave., Gloversville, N. Y.
Orr, Milo M., 415 West 11th St., Oklahoma City, Okla.
Osborne, Clarence B., 749 Race St., Denver, Colo.
Overstreet, John B., 905-14 Scanlan Bldg., Houston, Texas.
Owen, Edgar W., 711 Tradesman's Bank Bldg., Oklahoma City, Okla.
Owens, Allen L., The Carter Co., Box 722, Parkersburg, West Va.,
Pack, R. W., Drawer 790, Beaumont, Texas.
Padgett, Fred W., Mellon Institute, Pittsburgh, Penna.
Paige, Sidney U. S. Geological Survey, Washington, D. C.
Panyity, Louis S., 301 Nineteenth Ave., Columbus, Ohio.
Parker, Everett C., 440 South Palm St., Ponca City, Okla.
Parsons, Frank B., Western Oil Fields Corp., Denver, Colo.
Patton, Horace B., 3149 West 44th St., Denver, Colo.
Peabody, Harlan W., Box 149, Stroud, Okla.
Pellekaan, W. van Holst, Roxana Petroleum Corp., Arcade Bldg., St. Louis, Mo.
Pemberton, J. R., Box 1112, Tulsa, Oklahoma.
Pepperberg, Leon J., American Exchange Nat'l Bank Bldg., Dallas, Texas.
Perkins, Joseph M., 1218 Colcord Bldg., Oklahoma City, Okla.
Perrine, Irving, 301-3 Baum Bldg., Oklahoma City, Okla.
Peterson, Clarence J., c|o A. B. Rowley, 1559 S. Yorktown Ave., Tulsa, Okla.
Petty, Dabney E., 10 - 10th St., San Antonio, Texas.
Pishel, Max A., Box 204, Tulsa, Okla.
Plata, Belisario, Apartado 224, Bogota, Columbia, S. A.
Plummer, F. B., Box 1080, Houston, Texas.
Porch, Edwin L., Jr., Box 573, San Antonio, Texas.
Potter, G. C., Box 2046, Tulsa, Okla.
Powers, Sidney, Box 2022, 917 Petroleum Bldg., Tulsa, Okla.
Pratt, Wallace E., 911 Humble Bldg., Houston, Texas.
Price, Sylvan S., 704 First Nat'l Band Bldg., Tulsa, Okla.
Prommel, Harald W. C., 781 S. Downing St., Denver, Colo.
Prout, F. S., Box 508, Pawhuska, Okla.
Purdy, C. Wesley, 38 Francis Ave., Cambridge, Mass.
Pyle, James R., 5539 Elsworth Ave., Pittsburgh, Pa.

Radcliffe, Donald H., 907 South Alabama St., Okmulgee, Okla.
Rae, Colin C., 510 First Nat'l Bank Bldg., Denver, Colo.
Randolph, E. Oscar, Box 286, College Station, Texas.
Ravicz, Louis, Hayden, Stone & Co., 25 Broad St., New York City.
Read, M. K., 211 Commercial Nat'l Bank Bldg., Muskogee, Okla.
Reed, Ralph D., Stanford University, California.
Reeds, A. C., 1123 West 40th St., Oklahoma City, Okla.
Rees, Forest R., 46 North Zunis Ave., Tulsa, Okla.
Reeves, Frank W., F. & M. Nat'l Bank Bldg., Fort Worth, Texas.
Reger, David B., Box 816, Morgantown, W. Va.
Reisher, Paul H., c|o Gypsy Oil Co., Tulsa, Okla.
Reynolds, Roy A., Box 1096, Eastland, Texas.
Rich, John L., Box 3, Ottawa, Kansas.
Richards, Esther E., 326 Southern Pacific Bldg., Houston, Texas.
Richards, Ralph, 405 Westory Bldg., Washington, D. C.
Riddle, Donald D., 141 Broadway, Suite 918, New York City.
Rider, Charles R., Apartado 150, Tampico, Mexico.
Riggs, Robert J., 604 First Nat'l Bank Bldg., Tulsa, Okla.

Ring, Dewitt T., Box 40, Tulsa, Okla.
Roark, Edward L., 400 S. Palm, Ponca City, Okla.
Roark, Louis, Box 1266, Okmulgee, Okla.
Roark, Ralph B., c|o Comar Oil Co., Marland, Okla.
Roberts, John R., Room 5009 Interior Bldg., Washinton, D. C.
Roberts, Morgan E., c|o H. B. M. Consulate, Fez, Morocco.
Robinson, Ernest G., Moore, Montana.
Robinson, Heath M., Great Southern Life Bldg., Dallas, Texas.
Robinson, J. French, 545 William Penn Way, Pittsburgh, Penna.
Robinson, Wilber I., Michigan Geological Survey, Lansing, Mich.
Rockwell, Fred G., Big Sandy Coal Co., Pikeville, Kentucky.
Rogers, Reese F., Box 1805, Texas Co., Houston, Texas.
Rogers, Ola J., Cleveland, Okla.
Rollin, George S., c|o Roxana Petroleum Corp., Tulsa, Okla.
Ross, Clarence S., U. S. Geological Survey, Washington, D. C.
Ross, J. C. Twin State Oil Co., Tulsa, Okla.
Rothrock, E. Paul, 308 Yale St., Vermilion, South Dakota.
Rothrock, Howard E., Box 428, Lexington, Kentucky.
Roundy, P. V., U. S. Geological Survey, Washington, D. C.
Row, Charles H., Box 1109, Dallas, Texas.
Rowe, J. P., 341 University Ave., Missoula, Montana.
Rowley, Alden B., 10 East Fifteenth St., Tulsa, Okla.
Ruby, Glen M., 935 St. Paul St., Denver, Colo.
Ruedemann, Paul, 505 Atlas Bldg., Tulsa, Okla.
Russ, Leon F., c|o Albany Nat'l Bank, Albany, Texas.
Russell, Philip G., Bed Rock Co., Paintsville, Kentucky.

Sands, J. M., Phillips Petroleum Co., Bartlesville, Okla.
Schieferdecker, A. A. G., Apartado 238, Tampico, Tamps., Mexico.
Scholl, Louis A., Jr., c|o C. E. Hermann, 17 Battery Place, New York City.
Schramm, E. F., Station A, Box 1258, Lincoln, Nebraska.
Schroeder, Rolf A., 94 Perkins St., Jamaica Plains, Boston, Mass.
Schroyer, C. R., Worthington, Ohio.
Schuchert, Charles, Yale University, New Haven, Conn.
Schwarzenbek, U. S. Bureau of Mines, Bartlesville, Okla.
Scott, H. M., 906 Petroleum Bldg., Tulsa, Okla.
Scott, Walter W., 614 Merchants Bldg., Shreveport, La.
Scudder, E. W., 1211 East 5th Ave., Winfield, Kansas.
Sealey, Fred C., Texas Co., Geology Dept., Houston, Texas.
Segall, Julius, El Oro Mg. & Ry. Co., Avenida Juarez, Mexico City, Mex.
Sellards, E. H., University of Texas, Austin, Texas.
Semmes, Douglas R., Cia Mexicana de Petroleo "El Aguila," S. A.
Severy, C. L., 725 Kennedy Bldg., Tulsa, Okla.
Shannon, Charles W., Norman, Okla., Okla. Geological Survey.
Shaw, Eugene W., 170 Broadway, New York City.
Shaw, Everett S., 3129 Zenobia St., Denver, Colo.
Shearer, Harold K., 510 East Liberty St., Springfield, Ohio.
Sheldon, Israel R., Box 1001, Wichita Falls, Texas.
Shepard, Edward M., 1403 Benton Ave., Springfield, Mo.
Shiarella, Nicholas W., 731 Fifth Ave., New Kensington, Penna.
Shidel, Harold R., Box 865, Wichita, Kansas.
Shuler, Ellis W., Southern Methodist University, Dallas, Texas.
Sickler, Jack M., Geological Dept., Midwest Refining Co., Denver, Colo.
Simonds, Frederic W., University of Texas, Austin, Texas.
Sinclair, E. G., 421 Devine St., Casper, Wyoming.
Singewald, Joseph T., Jr., 17 West 29th St., Baltimore, Md.
Small, Walter M., Cooperstown, Penna.

Smith, Carl D., Box 1136, Tulsa, Okla.
Smith, George O., Director, U. S. Geological Survey, Washington, D. C.
Smith, E. Eggleston, Box 143, Sioux City, Iowa.
Smith, Lloyd B., 2617 Dillard St., Shreveport, La.
Smith, Richard A., 423 North Pine St., Lansing, Mich.
Snider, L B., 1617 South Troost St., Tulsa, Okla.
Snider, L. C., Bartlesville, Okla., Empire, Co.
Snow., Dale R., 2013 East Hodge St., Tulsa, Okla.
Snyder, John Y., 1211 Merchants Bldg., Shreveport, La.
Somers, Ransom E., Oil & Gas Bldg., University of Pittsburgh, Pittsburgh, Pa.
Spooner, W. C., Box 94, Shreveport, La.
Springfield, Carl K., Box 427, Mansfield, La.
Stacy., Dean M., 1217 Colcord, Bldg., Oklahoma City, Okla.
Stalder, Walter, 925 Crocker Bldg., San Francisco, Calif.
Stander, Arthur E., Box 912, Tulsa, Okla.
Stathers, Silas C., Standard Oil Company of Louisiana, Shreveport, La.
Stauffer, Clinton R., 1120 Fifth St., S. E., Minneapolis, Minn.
St. Clair, Stuart, 350 Madison Ave., Room 812, New York City.
Stebinger, Eugene, Paseje Roverano Avenida de Mayo, 560 Session N. Buenos Aires, Argentina.
Stephenson, Cuthbert D., Box 923, Pawhuska, Okla.
Stephenson, Eugene A., Box 1255, Pittsburgh, Pa.
Steubing, W. C., 2417 Maine Ave., San Antonio, Texas.
Stevens, George R., 324 Washington Ave., Shreveport, La.
Stevens, John B., 2606 Durant Ave., Berkeley, Calif.
Stewart, Irvine E., Box 837, Billings, Mont.
Stewart, P. Charterisa, 51 Redcliffe Square, South Kensington, London, S. W., Eng.
Stoner, Reginald C., c|o G. H. Mayer, Edifico Condesa, Dept. G, 1., Mexico, D. F.
Storm, William W., The Sun Co., Dallas, Texas.
Straub, Charles E., Suite 1100, Bitting Bldg., Wichita, Kansas.
Stroud, Ben K., States Dept. of Conservation, 305-7 Ward Bldg., Shreveport, La.
Studt, Charles W., Box J, Yates Center, Kansas.
Suman, John R., 716 Southern Pacific Bldg., Houston, Texas.
Swigart, T. E. Bureau of Mines, Washington, D. C.

Taff, Joseph A., Sharon Bldg., 55 New Montgomery St., San Francisco, Calif.
Tansey, V. O., 2826 East 76th Place, Chicago, Ill.
Tarr, Russell S., 309 Drexel Bldg., Tulsa, Okla.
Tatum, James L., Box 717, Tulsa, Okla.
Taylor, Charles H., 324 Baum Bldg., Oklahoma City, Okla.
Teas, L. P., Louisiana Oil Refining Corp., Shreveport, La.
Tester, Allen C., Dept. of Geology, University of Wisconsin, Madison, Wisconsin.
Thom, William T., Jr., U. S. Geological Survey, Washington, D. C.
Thomas, C. R., 722 South Boston, Tulsa, Okla.
Thomas, J. Elmer, 751 First Nat'l Bank Bldg., 38 S. Dearborn St. Chicago.
Thompson, Arthur B., 18 St. Swithens Lane, London, S. E. England.
Thompson, Jean C., 700 Lamar St., Wichita Falls, Texas.
Thompson, R. R. Box 297, Thurber, Texas.
Thompson, Wallace C., The Sun Co., Dallas, Texas. Box 1109.
Tomlinson, Charles W., 1610 Bixby Ave., Ardmore, Okla.
Trager, Earl A., Apartado 31, Panuco, Vera Cruz, Mexico.
Trowbridge, Arthur C., University of Iowa, Iowa City, Iowa.
Trout, L. E. 207 Baum Bldg., Oklahoma City, Okla.
Truex, Arthur F., 612 Petroleum Bldg., Tulsa, Okla.
Trumball, Loyal W., 1835 Gaylord St., Denver, Colo
Tucker, Rietz C., 203 Simpson St., Morgantown, West Va.
Twenhofel, W. H., Science Hall, University of Wisconsin, Madison, Wis.

Udden, Johan A., University Station, Austin, Texas.
Udden, Jon A., 1140 South Owasso St., Tulsa, Okla.
Umpleby, Joseph B., University of Oklahoma, Norman, Okla.
Uri, Hubert N., 210 Tiger Bldg., Okmulgee, Okla.
Uhrlaub, Rudolf, 724 New Hampshire St., Lawrence, Kansas.

Valerins, M. M., Mayo Bldg., Tulsa, Okla.
Van Burgh, Lisle R., 801 South Gilpin St., Denver, Colo.
Van der Gracht, W. A. J. M. van Waterschoot, c|o Marland Refining Co., Ponca City, Okla.
Van der Linden, Bernard H., 143 Schuytstraat St., The Hague, Holland.
Vandiver, Vincent W., Standard Oil Co., Room 405, 18 Broadway, New York City.
Van Gogh, F. A. A., c|o Bataafsche Petroleum Maatschappij, 30 Carel van Bylandtlaan, The Hague, Holland.
Van Tuyl, Francis M., Colorado School of Mines, Golden, Colo.
Van Wijk, G. D., Address not known.
Veatch, A. C., 5 Central Drive, Port Washington, Long Island, N. Y.
Vernon, Irving James, Apartado 170, Cartegena, Columbia, S. A.
Ver Wiebe, Walter A., 193 - 12th Ave., Columbus, Ohio.
Vrang, Christin, 503 Scott Bldg., Salt Lake City, Utah.

Wagener, Charles H., 5843 Park, Chicago, Ill.
Wagner, Carroll M., 1003 Higgins Bldg., Los Angeles, Calif.
Waite, V. V., 906 Insurance Bldg., Dallas, Texas.
Walker, Lucian H., c|o The Standard Oil Co., of New York, Shanghai, China.
Walker, W. L., 368 Cavour St., Oakland, Calif.
Walters, Ray P., c|o H. E. Bedford, Jr., 82 Avenue de Champs Elysees, Paris, France.
Ward, Freeman, Drawer W, Wermilion, South Dakota.
Ware, Thomas T., Wade Hotel, Duncan, Oklahoma.
Warner, Charles A., 310 Beauclair Apts., Okmulgee, Okla.
Warner, Julius H., 317 Railway Exchange Bldg., Denver, Colo.
Washburne, Chester W., 2 Rector St., New York City.
Wasson, Theron, 709 South Guthrie St., Tulsa, Okla.
Weaver, Paul, Apartado 150, Tampico, Tamps., Mexico.
Wegemann, Carroll H., 722 East 7th Ave., Denver, Colo.
Weidman, Samuel, 814 Monnet St., Norman, Okla.
Welker, Geo. E., 420 West Third St., Oil City, Pa.
Wells, Samuel W., Petroleum Bldg., Okmulgee, Okla.
Welsh, LeRoy G., 1018 Mayo Bldg., Tulsa, Okla.
White, David, U. S. Geological Survey, Washington, D. C.
White, Edwin E., Graham, Texas.
White, I. C., Morgantown, West Va.
White, Kessack D., Seccion I, 5 Piso, Aveneda de Mayo 560, Buenos Aires, Argentina.
White, L. Ansel, Barnes Oil & Gas Co., Barnes, Kansas.
Whitehead, R. Brooks, 310 Amer. Exc. Nat'l Bank, Dallas, Texas.
White, Luther H., 219 E. Jasper St., Tulsa, Okla.
Whitney, F. L., University of Texas, Austin, Texas.
Whitwell, E. V., 906 So. Boston Apts., Tulsa, Okla.
Whyman, Lawrence O., Box 545, Enid, Okla.
Williams, A. J. 5735 Calumet Ave., Chicago, Ill.
Williams, D. W., 1919 Rhode Island St., Lawrence, Kansas.
Wililams, W. A., 25 Broad St., Pierce Oil Corp., New York City.
Wilson, Edward B., Atlantic Oil Producing Co., Oklahoma City, Okla.
Wilson, Malcolm E., Box 1460, Fort Worth, Texas.
Wilson, Roy A., University of Montana, Missoula, Montana.
Wilson, Walter B., Box 2044, Tulsa, Okla.
Witteveen, G., Caribbean Petroleum Co., Caracas, Venezuela, S. A.

Winton, Will M., Texas Christian University, Fort Worth, Texas.
Witt, Herbert N., 512 Sharon Bldg., San Francisco, Calif.
Winchester, Dean E., 1916 Elm St., Denver, Colo.
Wood, Virgil O., 516 Daniel Bldg., Tulsa, Okla.
Wood, Robert H., 516 Daniel Bldg., Tulsa, Okla.
Woolsey, E. V., Amer. Exc. Nat'l Bank Bldg., Dallas, Texas.
Woodruff, E. G., Box 1484, Tulsa, Okla.
Wrather, Wm. E., 6044 Bryan Parkway, Dallas, Texas.
Wright, Arthur P., Petroleum Bdlg., Tulsa, Okla., Riverland Oil Co.
Wright A. T., Douglas Oil Co., Pawhuska, Okla.
Wright, Harry F., 1227½ S. Main St., Tulsa, Okla.
Wright, Frederick S., Box 85, Belt, Montana.

Yoakam, Coler A., c|o Atlantic Oil Producing Co., Dallas, Texas.
Young, L. J., 1318 Denver St., Tulsa, Okla.
Younkman, Harry, Box 1301, Tulsa, Okla.
Ziegler, Victor, No address.
Zimmerman, James Z., Delmont, Westmoreland Co., Penna.
Zoller, Lawrence J., 406 Exchange Nat'l Bank Bldg., Tulsa, Okla.

Associate Members

Allison, A. P., Kearney, Nebraska.
Andrews, George L., Standard Oil Co., of Calif., Montebello, Baldwin Lease, Calif.
Arnold, Arthur L., 7934 Susquehanna St., Pittsburgh, Penna.
Arnold, James E., Box 1501, Tulsa, Okla.
Atkinson, William H., 2C8 North Robinson St., Oklahoma City, Okla.
Aylesvury, Miss Dorothy G., 317-19 Johnstone Ave., Bartlesville, Okla.

Baden, M. W., Box 520, Winfield, Kansas.
Ballard, Andrew L., Box 630, Cameron, Texas.
Belford, Leland S., Augusta, Kansas.
Bell, Olin G., Geology Dept., Cornell University, Ithaca, N. Y.
Best, J. Boyd, 2406 Cresswell St., Shreveport, La.,
Bingham, Dwight H., 1229 South Cheyenne Ave., Tulsa, Okla.
Black, Glenn W., Brea, Calif.
Blanchard, J. B., Purcell, Okla.
Boswell, John S., Nucla, Colo.
Boyle, George R., 215 East 11th St., Oklahoma City, Okla.
Bradley, Everett L., Cherokee, Okla.
Braugh, Donald D., Granger, Yakima County, Washington.
Briscoe, Glenn O., c|o Marland Refining Co., Ponca City, Okla.
Brittain, Reuben E., Jr., 231 E. 12th St., Oklahoma City, Okla.
Bullard, Fred M., Norman, Okla., Okla., Geological Survey.
Butcher, Seldon D., 430 West Symmes, Norman, Okla.

Campbell, Gordon M., 118 Woodland Ave., Lexington, Kentucky.
Carpenter, Marble J., 406 Lahoma, Norman, Okla.
Cary, William T., Arkansas City, Kansas.
Case, William B., 5010 Interior Bldg., Washington, D. C.
Cheyney, Alvin E., Box 4, Eureka, Kansas.
Clark, Howell Smith, Box 87, Okemah, Okla.
Collins, Wallace H., 1709 S. Carson Ave., Tulsa, Okla.
Conkling, Russell C., 304 E. Hughbert St., Norman, Okla.
Conkling, Wm. M., 304 E. Hughbert St., Norman, Okla.
Cook, Carroll E., Sinton, Texas.
Cottingham, Virgil E., Okemah, Okla.
Cox. Hubert D., Cedar Vale, Kansas.
Cummins, R. H., Box 1052, Bartlesville, Okla.

Daniels, Harold G., Marland Oil Co., Ponca City, Okla.
Denison, A. R., 917 Petroleum Bldg., Amerada Oil Corp, Tulsa, Okla.
Disney, Orville A., Bartlesville, Okla.
Dolphin, Adrian J., Box 274, Bowling Green, Ky.
Dunlap, Gilmore S., 86 S. Wade Ave., Washington, Penn.
Dunn, George V., Box 1263, Ponca City, Okla.

Eagles, Homer M., Room 1490, 170 Broadway, New York City.
Eckert, Frank E., Ridgway, Penna.
Erwin, Andrew V., 1138 S., Frankfort St., Tulsa, Okla.
Evans, Noel, South Third St., Hugo, Okla.

Fitch, Miss Frederika, Drawer D 15, St. Louis, Mo.
Foster, Alden W., 5715 Kentucky Ave., Pittsburgh, Pa.
Foster, F. K., 1446 S St., Lincoln, Nebraska.
Frost, Jack, c|o Humphreys Oil Co., Great South Life Bldg., Dallas, Texas.

Galloway, John O., 1715 N. Hudson, Oklahoma City, Okla.
Griffith, Cunningham L., La Espuela Oil Co., Apartado 1390, Tampico, Tamps, Mex.
Gish, Wesley G., Box 236, White Eagle Co., Wichita, Kansas.
Goff, Lee B., Jr., 1012 East 12th St., N., Portland, Ore.
Graham, Almon J., 504 W. Delavan Ave., Buffalo, N. Y.
Greene, Ray G., 315 Linden Walk, Lexington, Ky., Vulcan Oil Co.
Gretzinger, Wm., Carib Trading Co., Cartagena, Colombia, S. A.
Gross, P. S., 122 W. 5th St., Kansas City, Mo.

Hamm, William D., Box 1266, Okmulgee, Okla.
Hanson, Leslie C., Morris, Ill.
Hardin, E. Glenn, 318 E. 15th St., Oklahoma City, Okla.
Harper, Oliver C., 207 Peecan St., Sweetwater, Texas.
Harlowe, Leslie S., Box 1460, Fort Worth, Texas.
Harrington, Rollin B., 501 Petroleum Bldg., Okmulgee, Okla.
Hay, Laurence C., Box 1109, The Sun Co., Dallas, Texas.
Henderson, George H., Oakwood, Okla.
Hoffman, Malvin G., The Carter Oil Co., Tulsa, Okla.
Holl, Frederick G., Box 71, El Dorado, Kansas.
Holloman, Roy, 5575 Victor St., Dallas, Texas.
Hood, Harold H., Box 43, Litchfield, Ill.
Hoots, William H., Geology Dept., University of Kansas, Lawrence, Kansas.
Howe, Albert B., 58 Claremont Ave., Buffalo, N. Y.
Howendobler, John L., Box 541, Tulsa, Okla.
Hummel, Carl B., Pleasant Hill, Mo.
Hoyt, William V., 117 East Haskell St., Tulsa, Okla.
Huntley, Charles S., 505 Frick Bldg., Pittsburgh, Pa.

Johnson, Russell V., 115 N. 27th St., Box 127, Billings, Montana.
Jones, Boone, 318 E. 15th St., Oklahoma City, Okla.

Keenan, J. K., 224 W. Deleware, Tahlequah, Okla.
Kelsey, Frank B., c|o Standard Oil Co., Bin 15, Bakersfield, Calif.
Kennedy, Robert E., Worland, Wyoming.
Kingsbury, Carl O., c|o Pure Oil Co., 626 Stanley Hotel, Ardmore, Okla.
Kolm, Robert N., 1303 State St., Bowling Green, Ky.
Krause, F. Arthur, Rolla, Missouri.
Kroenliein, George A., c|o Sinclair Co., Box 2026, Tulsa, Okla.

Langworthy, A. A., Box 1238, Henryetta, Okla.
La Rue, James E., Humble Refining Co., Houston, Texas.
Lewis, Frank E., 61 Lake Place, New Haven, Conn.
Linker, Sophie, 970 Eastern Parkway, Brooklyn, N. Y.

Lively, Wililam P., Apartado 216, Tampico, Mexico. c|o Cortez Oil Co.
Lloyd, Abe M., c|o Absaroka Oil Development Co., Billings,Montana.
Loofbourrow, Robert B., Beaver, Okla.
Lydell, Jessie K., c|o Lydell Candy Mfg. Co., Shreveport, La.
Lynn, Robert H., 3210 Clive St., Kansas City, Mo.

McArthur, Donald, Address not known.
McClure, Joseph D., 118 S. Deleware St., Bartlesville, Okla.
McKown, Dave R., 767 Asp Ave., Norman, Okla.
McLaughlin, Homer C., Box 269, Graham, Texas.
McNeese, Charles H., Marland Oil Co., Ponca City, Okla.
Meland, Norman, 1711 Marshall Ave., St. Paul, Minn.
Meyer, Arthur M., The Texas Co., Box 912, Tulsa, Okla.
Miller, Forrest J., The Texas Co., Producing Dept., Shreveport, La.
Moser, Gerald E., Box 379, Bartlesville, Okla.
Morse, Paul F., Mississippi Geological Survey, Jackson, Miss.
Mulky, Francis P., 201 West 14th St., Oklahoma City, Okla.
Murphy, Earle N., 416 S. Ala., Okmulgee, Okla.

Nelson, Jean O., Box 94, Shreveport, La.
North, Lloyd, Texas Co., Geological Dept., Houston, Texas.
Neuenschwander, Paul W., Sistersville, W. Va.

Oyster, Frank A., 110 E., Mea St., Paola, Kansas.

Packard, Sidney A., 220 W. 6th St., Oklahoma City, Okla.
Paschal, Elisha A., 1206 First Nat'l Bank Bldg., Oklahoma City, Okla.
Patrick, Walden W., c|o The Carter Oil Co., Tulsa, Okla.
Pease, Cecil C., 1261 Buchanan St., Topeka, Kansas.
Philbrook, J. Brayton, c|o Union Oil Co., of Calif., Brea, Calif.
Plagmann, Albert D., 301 W. 9th Ave., Winfield, Kansas.
Pool, Harold, Haskell, Okla.
Pratt, Ernest S., 421 W. Eufaula, Norman, Okla.
Preece, Rae, Barnsdall Corp., Petroleum Bldg., Tulsa, Okla.
Price, Earl M., Rainbow Hotel, Shelby, Montana.

Quiett, Roy C., 207 W. Markham St., Little Rock, Ark.

Radler, Dollie, 915 Petroleum Bldg., Tulsa, Okla.
Ramsey, R. H., 509 Simpson Bldg., Ardmore, Okla.
Reed, Lyman C., Rio Bravo Oil Co., 820 S. P. Bldg., Houston, Texas.
Reed, Warren B., Morgan City., La.
Reiter, Wilhelm A., 1904 Magnolia Bldg., Dallas, Texas.
Rentfrow, Frank M., Address not known.
Reynolds, Karl W., Transcontinental Oil Co., Tulsa, Okla.
Ridgeway, Bertrand S., Box 403, Garnett, Kansas.
Robinson, B. F., Box 912, Tulsa, Okla.
Roop, Charles W., Indian Territory Oil Co., Bartlesville, Okla.
Roth, Ernest E., Pleasantville, Penna.
Rubel, Albert C., Stronghold Ranch, Cochise, Ariz.
Rubey William W., U. S. Geological Survey, Washington, D. C.
Russom, Vaughn W., 719 N. 16th St., Lincoln, Neb.

Sawtelle, George, 1815 Holman Ave, Houston, Texas.
Sawyer, Roger W., c|o Y. M. C. A., Oklahoma City, Okla.
Schappler, Rudolph C., Address not known.
Schnurr, Cornelius, Box 2024, Tulsa, Okla.
Schoeneck, Philip S., 302 Moise Bldg., Lexington, Ky.
Schoolfield, R. F., 206 Sinclair Bldg., Shreveport, La.
Scott, Gayle, T. C. U., Fort Worth, Texas.

Shea, E. F., Bradstreet Oil Co., Cosden Bldg., Tulsa, Okla.
Sidwell, Carroll V., 314 Security Bldg., Oklahoma City, Okla.
Simpson, Earl J., 114 N. Boulevard, Norman, Okla.
Skirvin, Orren W., Skirvin Hotel, Oklahoma City, Okla.
Smith, Evan, 123 N. Grand St., Los Angeles, Calif.
Smith, Merritt B., 244 N. Bellefield Ave., Pittsburgh, Penna.
Smoots, John P., Box 166, Eldorado, Ark.
Staggs, Olan B., Athlantic Oil Producing Co., Oklahoma City, Okla.
Stanley, M. Wood, Box 742, Corsiciana, Texas.
Solliday, Albert L., 114 Church St., Watertown, Wis.
Stahl, William J., Address not known.
Steinmayer, R. A., Address not known.
Stiles, Edmund B., c|o Humphreys Mexia Co., 1320 Great Southern Life Bldg., Dallas, Texas.
Stilley, Earl M., Empire Gas & Fuel Co., Bartlesville, Okla.
Stone, Jeptha C., Address not known.
Stoner, Oscar E., Box 658, Okmulgee, Okla.
Suman, George O., Jr., Oil Center, Calif., c|o Associated Oil Co.

Teas, Paul C., 130 West Eufaula St., Norman, Okla.
Teets, D. Dee, Jr., Box 693, Okemah, Okla.
Thompson, T. C., Box 1266, Okmulgee, Okla.
Thompson, V. A., Mountain View, Okla.
Thralls, Warren H., Wellington, Kansas.
Tweedy, Joseph L., Box 419, Dallas, Texas.

Upham, Harry R., Mineral Wells, Texas.

Van Dall, John E., 601 Deleware, Bartlesvile, Okla.

Waldo, Kenneth C., 952 Colbert Ave., Oil City, Pa.
Warner, J. Laird, Ten Sleep, Wyoming.
Waters, (Mrs., V. S. Chase), The Carter Co., Tulsa, Okla.
Webster, Hugh B., Standard Oil Co., Standard Oil Bldg., San Francisco, Calif.
Watson, Joseph D., 408 Daniel Bldg., Tulsa, Okla.
Weinzierl, John F., Geological Dept., Marland Oil Co., Ponca Cit, Okla.
Weirich, Eugene, White City, Kansas.
Wheeler, Carlton W., Muldrow, Okla.
Wiest, Frank C., Atlantic Prod. Co., McCormick Bldg., Bowling Green, Ky.
Willis, S. M., Address not known.
Wilson, John H., Box 91, Golden, Colo.
Wilson, Joseph M., 1713 South Adams, Fort Worth, Texas.
Wright, Andrew C., 206 Sinclair Bldg., Shreveport, La.
Wright, Mary E., Roxana Petroleum Corp., Tulsa, Okla.
Wylie, James R., Jr., 424 Whitney Ave., Wilkinsburg, Penna.

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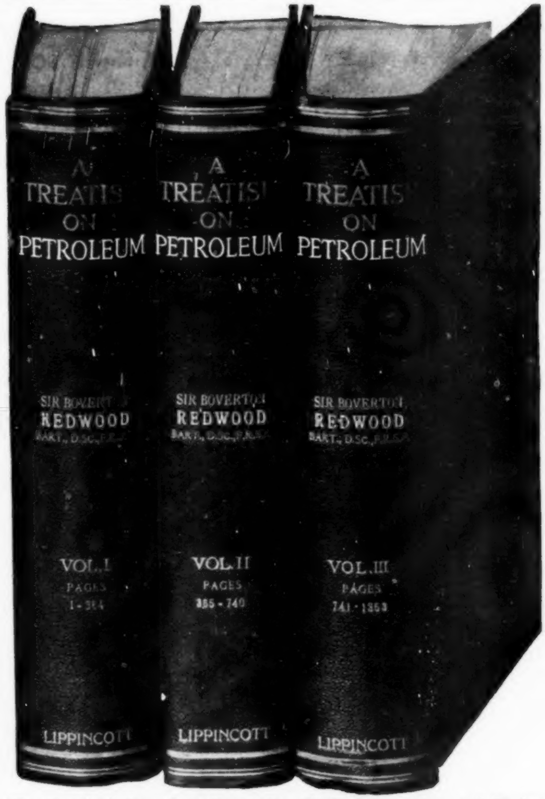
ADDRESS: J. ELMER THOMAS, ADVERTISING MANAGER, 751 FIRST NATIONAL BANK BUILDING, CHICAGO, ILLINOIS.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INDEX TO VOLUME VI

PAGE

Age of the Barnett (Lower Bend) Shale of Central Texas. Geological Note by Raymond C. Moore 150
American Association of Petroleum Geologists, Denver Meeting of the. Report by Charles E. Decker. The Association Round Table . 557
———. Member List of 572
———. The Seventh Annual Meeting, Oklahoma City, Oklahoma. Report by R. C. Moore. The Association Round Table . . 162
Anticlines, Gulf of Paria, Trinidad-Venezuela, Possible Sub-Sea. Geological Note by Lewis C. Chapman 474
Arbuckle Mountains, Arkose North of the. Review 161
Arizona, On the Statigraphy of Northeastern. Discussion by Raymond C. Moore 47
Arkansas, El Dorado Field, Age of the Producing Sand. Geological Note by the U. S. Geological Survey 54
———. El Dorado Oil Field in, not on an Anticline. Geological Note by K. C. Heald and W. W. Rubey 358
———. New Producing Depths at El Dorado. Geological Note by L. P. Teas 473
———. Oil and Gas Field, El Dorado. By H. W. Bell and J. B. Kerr. Review by Sidney Powers 554
———. The El Dorado, Oil Field and Its Relation to North Louisiana Structures. By A. F. Crider 193
———. Wildcat Oil Exploration in South-Central. Geological Note by W. W. Rubey 350
———. Wildcat Wells in South-Central, Stop Short of Deep Oil Sands. Discussion by J. P. D. Hull 477
Arkose North of the Arbuckle Mountains. Review 161
Arnold, Ralph, and Loel, Wayne. New Oil Fields of the Los Angeles Basin, California 303
Association Round Table, The 162, 266, 392, 489, 557
At Home and Abroad 61, 170, 276, 394, 493, 570

Barnett (Lower Bend) Shale of Central Texas, Age of. Geological Note by Raymond C. Moore 150
Bauer, A. D., Cook, M. B., and Dean, E. W. Properties of Typical Crude Oils from the Producing Fields of Kansas. Geological Note 370
Bell, H. W. and Cattell, R. A. The Monroe Gas Field, Louisiana. Review by J. Wallace Bostick 155
Bell, H. W. and Kerr, J. B. El Dorado, Arkansas, Oil and Gas Field. Review by Sidney Powers 554

PAGE
Bellevue Pool, Louisiana, The. Geological Note by J. P. D. Hull . 247
Bibliographies, Manuscript. Review by Sidney Powers . . . 488
Bloesch, Edward. Remarks on Surface Contouring 317
Bostick, J. Wallace. Review of The Monroe Gas Field, Louisiana, by H. W. Bell and R. A. Cattell 155
British Columbia, The Petroleum Geology of a Part of the Western Peace River District. By Edmund M. Spieker 112
Button-Willow, Kern County, California, Oil and Gas Prospects in the Vicinity of. By R. M. Ferguson. Review by K. C. Heald . 57

California, Lower. Review 60
———. Oil and Gas Prospects in the Vicinity of Button-Willow, Kern County. By R. M. Ferguson. Review by K. C. Heald . . 57
Carbonaceous Shales, Organic Material of. By Colin C. Rae . . 333
Carpathians, Geological Work in the. By Winthrop P. Haynes . . 523
Cattell, R. A. and Bell, H. W. The Monroe Gas Field, Louisiana. Review by J. Wallace Bostick 155
Chapman, Lewis C. Possible Sub-Sea Anticlines, Gulf of Paria, Trinidad-Venezuela. Geological Note 474
Cheney, Chas. A. Salt Domes of Northeastern Texas. Review by K. C. Heald 58
Coal Tar, Natural, Mistaken for Oil Residue. By George C. Martin . 293
Collapsing Pressures, Mud Laden Fluids and Tables on Specific Gravities. By Ben K. Stroud. Notice 382
Committee Work. By W. E. Wrather. The Association Round Table 489
Cook, M. B., Dean, E. W., and Bauer, A. D. Properties of Typical Crude Oils from the Producing Fields of Kansas. Geological Note . 370
Cox, Guy Henry. Obituary by V. H. McNutt 566
Craig, E. H. Cunningham. Oil Finding. Review by K. D. White . 485
Crider, A. F. The El Dorado, Arkansas, Oil Field and Its Relation to North Louisiana Structures 193
Crude Oils from the Producing Fields of Kansas, Properties of Typical. Geological Note by E. W. Dean, M. B. Cook, and A. D. Bauer . 370

Dakota, Oil Possibilities of South. Geological Note by W. T. Thom, Jr. 551
Dean, E. W., Cook, M. B., and Bauer, A. D. Properties of Typical Crude Oils from the Producing Fields of Kansas. Geological Note . 370
Decker, Charles E., Report of Denver Meeting of the American Association of Petroleum Geologists. The Association Round Table . 557
Denver Meeting of the American Association of Petroleum Geologists. Report by Charles E. Decker. The Association Round Table . 557
DeWolf, F. W. Professional Ethics. The Association Round Table . 393
Diamond Drill in Oil Exploration, The. By Robert Davis Longyear . 98
Diamond Drilling. Discussion, by P. W. Donovan 139
Diamond Drilling for Production. By Frank A. Edson 91
Differentiation and Structure of the Glenn Formation. By W. L. Goldsten, Jr. 5

PAGE
Discussion 47, 139, 377, 477
Distinguishing Fused Cores, a Method of. Geological Note by Clarence S. Ross 372
Dobbin, C. E., and Thom, Jr., W. T. Oil and Gas Prospects in Garfield County, Montana. Geological Note 144
Dodge, W. E. Notes to Inventor Geologists. Geological Note . . 50
Donovan, P. W. On Diamond Drilling. Discussion 139
Drill, Diamond, in Oil Exploration. By Robert Davis Longyear . 98
Drilling, Diamond, for Production. By Frank A. Edson . . . 91

Economic Aspects of Geology, The. By C. K. Leith. Review by James H. Hance 157
Editorial 545
———. By W. E. Wrather 348
Edson, Frank A. Diamond Drilling for Production 91
El Dorado, Arkansas, New Producing Depths at. Geological Note by L. P. Teas 473
———. Oil and Gas Field. By H. W. Bell and J. B. Kerr. Review by Sidney Powers 554
———. Oil Field and Its Relation to North Louisiana Structures. By A. F. Crider 193
El Dorado Field, Arkansas, Age of the Producing Sand. Geological Note by the U. S. Geological Survey 54
El Dorado Field, Butler County, Kansas, Is the Stapleton Pay Ordovician or Mississippian in Age? Geological Note by A. E. Fath . 374
El Dorado Oil Field in Arkansas not on an Anticline. Geological Note by K. C. Heald and W. W. Rubey 358
Ellison, Robert S. What the Oil Company Expects of the Geologist . 516
Engineering, the Necessity for, in Developing Oil and Gas Properties. Discussion by Ben K. Stroud 377
Estimation of Reserves of Natural Gas Wells by Relationship of Production to Closed Pressure. By Paul Ruedemann and Ionel Gardescu 444
Ethics, Professional. By F. W. DeWolf. The Association Round Table 393

Fath, A. E. Is the Stapleton Pay of the El Dorado Field, Butler County, Kansas, Ordovician or Mississippian in Age? Geological Note 374
Ferguson, R. M. Oil and Gas Prospects in the Vicinity of Button-Willow, Kern County, California. Review by K. C. Heald . . 57
Field Description of Sedimentary Rocks, A Schedule for the. Geological Note 254
Fox Oil and Gas Field, Carter County, Oklahoma. Geological Note by Willis Storm 367
Franklin, Louis. A Preliminary Study on the Recovery of Oil by Sinking Shafts and Driving Galleries 342
Fuller's Earth Deposit at Olmstead, Illinois. By Cullen W. Parmalee. Review by James H. Hance 155

PAGE

Gardescu, Ionel, and Ruedemann, Paul. Estimation of Reserves of Natural Gas Wells by Relationship of Production to Closed Pressure . 444
Gardner, James H. Rock Distortion on Local Structures in the Oil Fields of Oklahoma 228
Garfield County, Montana, Oil and Gas Prospects in. Geological Note by W. T. Thom, Jr., and C. E. Dobbin 144
Garvin County, Oklahoma, Occurrences of Limestone in. Geological Note by Harve Loomis 54
Gas Wells, Estimation of Reserves of Natural, by Relationship of Production to Closed Pressure. By Paul Ruedemann and Ionel Gardescu 444
Geologic Section in Western Kansas. Geological Note by Charles T. Lupton 549
Geological Notes 50, 142, 244, 350, 472, 549
Geological Work in the Carpathians. By Winthrop P. Haynes . . 523
Geologist, What the Oil Company Expects of the. By Robert S. Ellison 516
Geology, The Economic Aspects of. By C. K. Leith. Review by James H. Hance 157
Glenn Formation, Differentiation and Structure of the. By W. L. Goldston, Jr. 5
Goldston, Jr., W. L. Differentiation and Structure of the Glenn Formation 5
Goodrich, H. B. Review of Oil Land Development and Valuation, by R. P. McLaughlin 56
Granite, Oil "Showing" in, in South Africa Explained. Geological Note by K. C. Heald 360
Graphical Methods for Appraising Oil Wells. By Paul Ruedemann . 533
Gulf Coast Salt Dome, A New. Geological Note by Wallace E. Pratt . 252
Gulf of Paria, Trinidad-Venezuela, Possible Sub-Sea Anticlines. Geological Note by Lewis C. Chapman 474

Hance, James H. Review of Appraisal of Oil Production, by J. H. Highsmith 483
———. Review of Fuller's Earth Deposit at Olmstead, Ill., by Cullen W. Parmalee 155
———. Review of The Economic Aspects of Geology, by C. K. Leith 157
Hartley, Burton. Certain Relations Between Production and Structure in Northern Osage County, Oklahoma 464
Haynes, Winthrop P. Geological Work in the Carpathians . . . 523
Haynesville Field, Louisiana. Geological Note by L. P. Teas . . 53
———. Review 160
Haynesville, Louisiana, Field. Geological Note by L. P. Teas . . 371
Haynesville Oil Field, Louisiana, Preliminary Report on Underground Conditions in the. Geological Note by W. W. Scott . . . 142
Heald, K. C. Is It Injurious to Close in an Oil Well? Discussion . 379
———. Oil in Idaho? Geological Note 472
———. Oil in Middle Ordovician in Indiana. Geological Note . 374

PAGE

———. Oil "Showing" in Granite in South Africa Explained. Geological Note . . . 369
———. Review of Oil and Gas Prospects in the Vicinity of Button-Willow, Kern County, California, by R. M. Ferguson 57
———. Review of Salt Domes of Northeastern Texas, by Chas. A. Cheney 58
Heald, K. C., and Rubey, W. W. El Dorado Oil Field in Arkansas not on an Anticline. Geological Note 358
Healdton, Ordovician Oil at. Geological Note by Sidney Powers . 476
Highsmith, J. H. Appraisal of Oil Production. Review by James H. Hance 483
Howell, J. V. Pre-Permian Paleozoics of the Wichita Mountain Area 413
Hull, J. P. D. The Bellevue Pool, Louisiana. Geological Note . . 247
———. Webster Parish Gas Fields, Louisiana. Geological Note . 251
———. Wildcat Wells in South-Central Arkansas Stop Short of Deep Oil Sands. Discussion 477
——— and Spooner, W. C. A Review of Oil and Gas Pools in North Louisiana Territory 179
———. Note on A Review of Oil and Gas Pools in North Loulsiana Territory 259
Hunton Limestone Production in Oklahoma. Review 161

Idaho, Oil in? Geological Note by K. C. Heald 472
Illinois, Fuller's Earth Deposit at Olmstead. By Cullen W. Parmalee. Review by James H. Hance 155
———. Oil and Gas Fields of. Geological Note 153
Indiana, Oil in Middle Ordovician. Geological Note by K. C. Heald . 374
Inventor Geologists, Notes to. Geological Note by W. E. Dodge . 50
Isthmus of Tehuantepec. Review 60

Kansas, Geologic Section in Western. Geological Note by Charles T. Lupton 549
——. Is the Stapleton Pay of the El Dorado Field, Butler County, Ordovician or Mississippian in Age? Geological Note by A. E. Fath 374
———. Properties of Typical Crude Oils from the Producing Fields of. Geological Note by E. W. Dean, M. B. Cook, and A. D. Bauer . 370
———. Water Conditions in the Urschel Pool, Marion County. By E. F. Shea 426
———. Western, Oil Possibilities of. By Charles T. Lupton, Wallace Lee and L. R. Van Burgh 69

Kentucky, Oil Geology of Warren County. By Stuart St. Clair . . 24
Kerr, J. B. and Bell, H. W. El Dorado, Arkansas, Oil and Gas Field. Review by Sidney Powers 554
Kew, W. T. W. Review of Unproved Areas, by Lawrence Vander Leck 481

PAGE

Lahee, F. H. Temperature of Fluids in Wells. Research Problem . 547
Lee, Wallace, Lupton, Charles T., and Van Burgh, L. R. Oil Possibilities of Western Kansas 69
Leith, C. K. The Economic Aspects of Geology. Review by James H. Hance 157
Limestone in Northeastern Garvin County, Oklahoma, Occurrence of. Geological Note by Harve Loomis 54
Longyear, Robert Davis. The Diamond Drill in Oil Exploration . 98
Loomis, Harve. Occurrence of Limestone in Northeastern Garvin County, Oklahoma. Geological Note 54
Los Angeles Basin, California, New Oil Fields of. By Ralph Arnold and Wayne Loel 303
Louisiana, Haynesville Field. Geological Note by L. P. Teas . . 53
———. Geological Note by L. P. Teas 371
———. Review 160
Louisiana, Preliminary Report on Underground Conditions in the Haynesville Oil Field. Geological Note by W. W. Scott . . 142
———. The Bellevue Pool. Geological Note by J. P. D. Hull . . 247
———. The Monroe Gas Field. By H. W. Bell and R. A. Cattell. Review by J. Wallace Bostick 155
———. Webster Parish Gas Fields. Geological Note by J. P. D. Hull 251
———. Structures, The El Dorado, Arkansas, Oil Field and Its Relation to North. By A. F. Crider 193
Louisiana Territory, A Review of Oil and Gas Pools in North. By J. P. D. Hull and W. C. Spooner 179
———. Note on 259
Lower California. Review 60
Lupton, Charles T. Geologic Section in Western Kansas. Geological Note 549
Lupton, Charles T., Lee, Wallace, and Van Burgh, L. R. Oil Possibilities of Western Kansas 69

Martin, George C. Natural Coal Tar Mistaken for Oil Residue . 293
McLaughlin, R. P. Oil Land Development and Valuation. Review by H. B. Goodrich 56
McNutt, V. H. Obituary of Guy Henry Cox 566
Melcher, A. F. Investigations on Permeability and Absorption of "Sands" for Oil, Water, and Gas, with Reference to their Normal and Possible Yield. Geological Note 143
Membership Applications Approved for Publication. The Association Round Table 167, 272, 490, 559
Membership List 572
Mexico, Southern. Geological Note 154
Michigan, Oil Prospecting in. By R. A. Smith. Review . . . 381
Midway Limestone of Northeast Texas. By Wallace C. Thompson . 323
Monett, V. E. Topographic Criteria of Oil Field Structure . . . 37

PAGE

Monroe Gas Field, Louisiana, The. By H. W. Bell and R. A. Cattell. Review by J. Wallace Bostick 155
Monroe Gas Field to New Orleans, Preliminary Report on Proposed Pipeline from the. By Ben K. Stroud and F. T. Payne. Review 383
Montana, Oil and Gas Prospects in Garfield County. Geological Note by W. T. Thom, Jr. and C. E. Dobbin 144
Moore, Raymond C. Age of the Barnett (Lower Bend) Shale of Central Texas. Geological Note 150
———. Discussion on the Stratigraphy of Northeastern Arizona . 47
———. Possible Oil in Southern Utah. Geological Note . . . 244
———. Report of the Seventh Annual Meeting of the American Association of Petroleum Geologists, Oklahoma City, Oklahoma. The Association Round Table 162
———. Stratigraphy of a Part of Southern Utah 199
———. Studies in Petroleum Geology. Editorial 545
Mud Laden Fluids and Tables on Specific Gravities and Collapsing Pressures. By Ben K. Stroud. Notice 382

New Publications 260, 488
New Orleans, Preliminary Report on Proposed Pipeline from the Monroe Gas Field to. By Ben K. Stroud and F. T. Payne. Review . 383

Obituary 563, 566
Officers, Election of. American Association of Petroleum Geologists . 271
———. Methods of Electing. The Association Round Table . . 167
Oil, Wildcat, Exploration in South-Central Arkansas. Geological Note by W. W. Rubey 350
Oil and Gas Fields of Illinois. Geological Note 153
Oil and Gas Pools in North Louisiana Territory, A Review of. By J. P. D. Hull and W. C. Spooner 170
——— Note on 259
Oil and Gas Properties, The Necessity for Engineering in Developing. Discussion by Ben K. Stroud 377
Oil and Gas Prospects in Garfield County, Montana. Geological Note by W. T. Thom, Jr. and C. E. Dobbin 144
Oil at Healdton, Ordovician. Geological Note by Sidney Powers . 476
Oil Exploration, The Diamond Drill in. By Robert Davis Longyear . 98
Oil Field Structure, Topographic Criteria of. By V. E. Monett . . 37
Oil Fields, New, of the Los Angeles Basin, California. By Ralph Arnold and Wayne Loel 303
Oil Fields of Oklahoma, Rock Distortion on Local Structures in the. By James H. Gardner 228
Oil Finding. By E. H. Cunningham Craig. Review by K. D. White 485
Oil Geology, Problems in, and Their Advancement through Co-operative Research. By David White 509
Oil Geology of Warren County, Kentucky. By Stuart St. Clair . . 24
Oil in Idaho? Geological Note by K. C. Heald 472

PAGE

Oil in Middle Ordovician in Indiana. Geological Note by K. C. Heald 374
Oil in Southern Utah, Possible. Geological Note by Raymond C. Moore 244
Oil in Southwestern Texas, A Chance of More. Geological Note by L. W. Stephenson 475
Oil Land Development and Valuation. By R. P. McLaughlin. Review by H. B. Goodrich 56
Oil Possibilities of South Dakota. Geological Note by W. T. Thom, Jr. 551
Oil Possibilities of Western Kansas. By Charles T. Lupton, Wallace Lee and L. R. Van Burgh 69
Oil Production, Appraisal of. By J. H. Highsmith. Review by James H. Hance 483
Oil Prospecting in Michigan. By R. A. Smith. Review 381
Oil Residue, Natural Coal Tar Mistaken for. By George C. Martin . 293
Oil "Showing" in Granite in South Africa Explained. Geological Note by K. C. Heald 369
Oil Supply of the United States. By U. S. Geological Survey . . 42
Oil Well, Is it Injurious to Close it in? Discussion by K. C. Heald . 379
Oil Well in Scotland. Geological Note by Sidney Powers 376
Oil Wells, Some Graphical Methods for Appraising. By Paul Ruedemann 533
Oklahoma, Certain Relations Between Production and Structure in Northern Osage County. By Burton Hartley 464
———. Hunton Limestone Production in. Review 161
———. Occurrence of Limestone in Garvin County. Geological Note by Harve Loomis 54
———. Rock Distortion on Local Structures in the Oil Fields of. By James H. Gardner 228
———. The Fox Oil and Gas Field, Carter County. Geological Note by Willis Storm 367
———. The Seventh Annual Meeting of the American Association of Petroleum Geologists, Oklahoma City, Oklahoma. Report by R. C. Moore. The Association Round Table 162
Oklahoma City, March 9-11, 1922. Proceedings of the Seventh Annual Meeting of the American Association of Petroleum Geologists. The Association Round Table 266
Ordovician Oil at Healdton Geological Note by Sidney Powers . . 476
Organic Material of Carbonaceous Shales. By Colin C. Rae . . 333

Parmalee, Cullen W. Fuller's Earth Deposit at Olmstead, Ill. Review by James H. Hance 155
Payne, F. T. and Stroud, Ben K. Preliminary Report on Proposed Pipeline from the Monroe Gas Field to New Orleans. Review . 383
Peace River District, British Columbia, The Petroleum Geology of a Part of the Western. By Edmund M. Spieker 112
Permeability and Absorption of "Sands" for Oil, Water, and Gas, with Reference to their Normal and Possible Yield, Investigations on. Geological Note by A. F. Melcher 143

PAGE

Petroleum, A Treatise on. By Sir Boverton Redwood. Review by Sidney Powers 382
Petroleum Geology, Studies in. Editorial by Raymond C. Moore . 545
Petroleum Geology of a Part of the Western Peace River District, British Columbia. By Edmund M. Spieker 112
Powers, Sidney. Oil Well in Scotland. Geological Note . . . 376
———. Ordovician Oil at Healdton. Geological Note 476
———. Review o a Treatise on Petroleum, by Sir Boverton Redwood 382
———. Review of El Dorado, Arkansas, Oil and Gas Field, by H. W. Bell and J. B. Kerr 554
———. Review of Manuscript Bibliographies 488
Pratt, Wallace E. A New Gulf Coast Salt Dome. Geological Note . 252
Pre-Permian Paleozoics of the Wichita Mountain Area, Notes on the By J. V. Howell 413
Problems in Oil Geology and Their Advancement Through Co-operative Research. By David White 509
Producing Depths at El Dorado, Arkansas, New. Geological Note by L. P. Teas 473
Producing Sand, Age of the, El Dorado Field, Arkansas. Geological Note by the U. S. Geological Survey 54
Production, Diamond Drilling for. By Frank A. Edson 91
Production and Structure in Northern Osage County, Oklahoma, Certain Relations Between. By Burton Hartley 464
Professional Ethics. By F. W. De Wolf. The Association Round Table 393

Rae, Colin C. Organic Material of Carbonaceous Shales 333
Recovery of Oil by Sinking Shafts and Driving Galleries, A Preliminary Study on the. By Louis Franklin 342
Redwood, Sir Boverton. A Treatise on Petroleum. Review by Sidney Powers 382
Research, Problems in Oil Geology and Their Advancement Through Co-operative. By David White 509
Research Problems. Temperature of Fluids in Wells. By F. H. Lahee 547
Reserves of Natural Gas Wells, Estimation of, by Relationship of Production to Closed Pressure. By Paul Ruedemann and Ionel Gardescu 444
Reviews and New Publications 56, 155, 260, 381, 481, 554
Rock Distortion on Local Structures in the Oil Fields of Oklahoma. By James H. Gardner 228
Ross, Clarence S. A Method of Distinguishing Fused Cores. Geological Note 372
Rubey, W. W. Wildcat Oil Exploration in South-Central Arkansas. Geological Note 350
Rubey, W. W., and Heald, K. C. El Dorado Oil Field in Arkansas not on an Anticline. Geological Note 358
Ruedemann, Paul. Some Graphical Methods for Appraising Oil Wells 533

PAGE

Ruedemann, Paul, and Gardescu, Ionel. Estimation of Reserves of Natural Gas Wells by Relationship of Production to Closed Pressure . . . 444

St. Clair, Stuart. Oil Geology of Warren County, Kentucky . . . 24
Salisbury, Rollin D. Obituary by W. E. Wrather . . . 563
Salt Dome, A New Gulf Coast. Geological Note by Wallace E. Pratt 252
Salt Domes of Northeastern Texas. By Chas. A. Cheney. Review by K. C. Heald . . . 58
Schedule for the Field Description of Sedimentary Rocks. Geological Note . . . 254
Scotland, Oil Well in. Geological Note by Sidney Powers . . . 376
Scott, W. W. Preliminary Report on Underground Conditions in The Haynesville Oil Field, Louisiana. Geological Note . . . 142
Sedimentary Rocks, A Schedule for the Field Description of. Geological Note. . . . 254
Seventh Annual Meeting of the American Association of Petroleum Geologists, Oklahoma City, Oklahoma. Report by R. C. Moore. The Association Round Table . . . 162
Seventh Annual Meeting of the American Association of Petroleum Geologists, Proceedings of, Held in Oklahoma City March 9-11, 1922. Association Round Table . . . 266
Shea, E. F. Water Conditions in the Urschel Pool, Marion County, Kansas . . . 426
Smith, R. A. Oil Prospecting in Michigan. Review . . . 381
South Africa, Oil "Showing" in Granite Explained. Geological Note by K. C. Heald . . . 369
Spieker, Edmund M. The Petroleum Geology of a Part of the Western Peace River District, British Columbia . . . 122
Spooner, W. C., and Hull, J. P. D. A Review of Oil and Gas Pools in North Louisiana Territory . . . 179
———. Note on A Review of Oil and Gas Pools in North Louisiana Territory . . . 259
Stapleton Pay of the El Dorado Field, Butler County, Kansas. Is it Ordovician or Mississippian in Age? Geological Note by A. E. Fath . . . 374
Stephenson, L. W. A Chance for More Oil in Southwestern Texas. Geological Note . . . 475
Storm, Willis. The Fox Oil and Gas Field, Carter County, Oklahoma. Geological Note . . . 367
Stratigraphy of a Part of Southern Utah. By Raymond C. Moore . 199
Stratigraphy of Northeastern Arizona, On the. Discussion by Raymond C. Moore . . . 47
Stroud, Ben K. Mud Laden Fluids and Tables on Specific Gravities and Collapsing Pressures. Notice . . . 382
———. The Necessity for Engineering in Developing Oil and Gas Properties. Discussion . . . 377

PAGE

Stroud, Ben K. and Payne, F. T. Preliminary Report on Proposed Pipeline from the Monroe Gas Field to New Orleans. Review . 383
Surface Contouring, Remarks on. By Edward Bloesch 317

Teas, L. P. Haynesville Field, Louisiana. Geological Note . . . 53
———. The Haynesville, Louisiana, Field. Geological Note . . 371
———. New Producing Depths at Fl Dorado, Arkansas. Geological Note 473
Tehuantepec, Isthmus of. Review 60
Temperature of Fluids in Wells. By F. H. Lahee. Research Problems 547
Texas, A Chance of More Oil in Southwestern. Geological Note by L. W. Stephenson 475
———. Age of the Barnett (Lower Bend) Shale of Central. Geological Note by Raymond C. Moore 150
———. Salt Domes of Northeastern. By Chas. A. Cheney. Review by K. C. Heald 58
———. The Midway Limestone of Northeast. By Wallace C. Thompson 323
Thom, Jr., W. T. Oil Possibilities of South Dakota. Geological Note 551
Thom, Jr., W. T., and Dobbin, C. E. Oil and Gas Prospects in Garfield County, Montana. Geological Note 144
Thompson, Wallace C. The Midway Limestone of Northeast Texas 323
Topographic Criteria of Oil Field Structure. By V. E. Monnett . . 37
Trinidad-Venezuela, Possible Sub-Sea Anticlines, Gulf of Paria. Geological Note by Lewis C. Chapman 474

Underground Conditions in the Haynesville Oil Field, Louisiana, Preliminary Report on. Geological Note by W. W. Scott . . 142
United States, the Oil Supply of the. By United States Geological Survey 42
U. S. Geological Survey. Age of the Producing Sand, El Dorado Field, Arkansas. Geological Note 54
———. The Oil Supply of the United States 42
Unproved Areas. By Lawrence Vander Leck. Review by W. S. W. Kew 481
Urschel Pool, Marion County, Kansas, Water Conditions in the. By E. F. Shea 426
Utah, Possible Oil in Southern. Geological Note by Raymond C. Moore 244
———. Stratigraphy of a Part of Southern. By Raymond C. Moore 199

Van Burgh, L. R., Lupton, Charles T., and Lee, Wallace. Oil Possibilities of Western Kansas 69
Vander Leck, Lawrence. Unproved Areas. Review by W. S. W. Kew 481
Venezuela, Possible Sub-Sea Anticlines, Gulf of Paria, Trinidad. Geological Note by Lewis C. Chapman 474

PAGE
Warren County, Kentucky, Oil Geology of. By Stuart St. Clair . . 24
Water Conditions in the Urschel Pool, Marion County, Kansas. By E. F. Shea 426
Wayne, Loel, and Arnold, Ralph. New Oil Fields of the Los Angeles Basin, California 303
Webster Parish Gas Fields, Louisiana. Geological Note by J. P. D. Hull 251
Wells, Temperature of Fluids in. By F. H. Lahee. Research Problems 547
———. Wildcat, in South-Central Arkansas Stop Short of Deep Oil Sands. Discussion by J. P. D. Hull 477
White, David. Problems in Oil Geology and Their Advancement Through Co-operative Research 509
White, K. D. Review of Oil Finding, by E. H. Cunningham Craig . 485
Wichita Mountain Area, Notes on the Pre-Permian Paleozoics of the. By J. V. Howell 413
Wildcat Oil Exploration in South-Central Arkansas. Geological Note by W. W. Rubey 350
Wildcat Wells in South-Central Arkansas Stop Short of Deep Oil Sands. Discussion by J. P. D. Hull 477
Wrather, W. E. Committee Work. The Association Round Table . 489
———. Editorial 348
———. Membership Applications. The Association Round Table . 490
———. Obituary of Rollin D. Salisbury 563